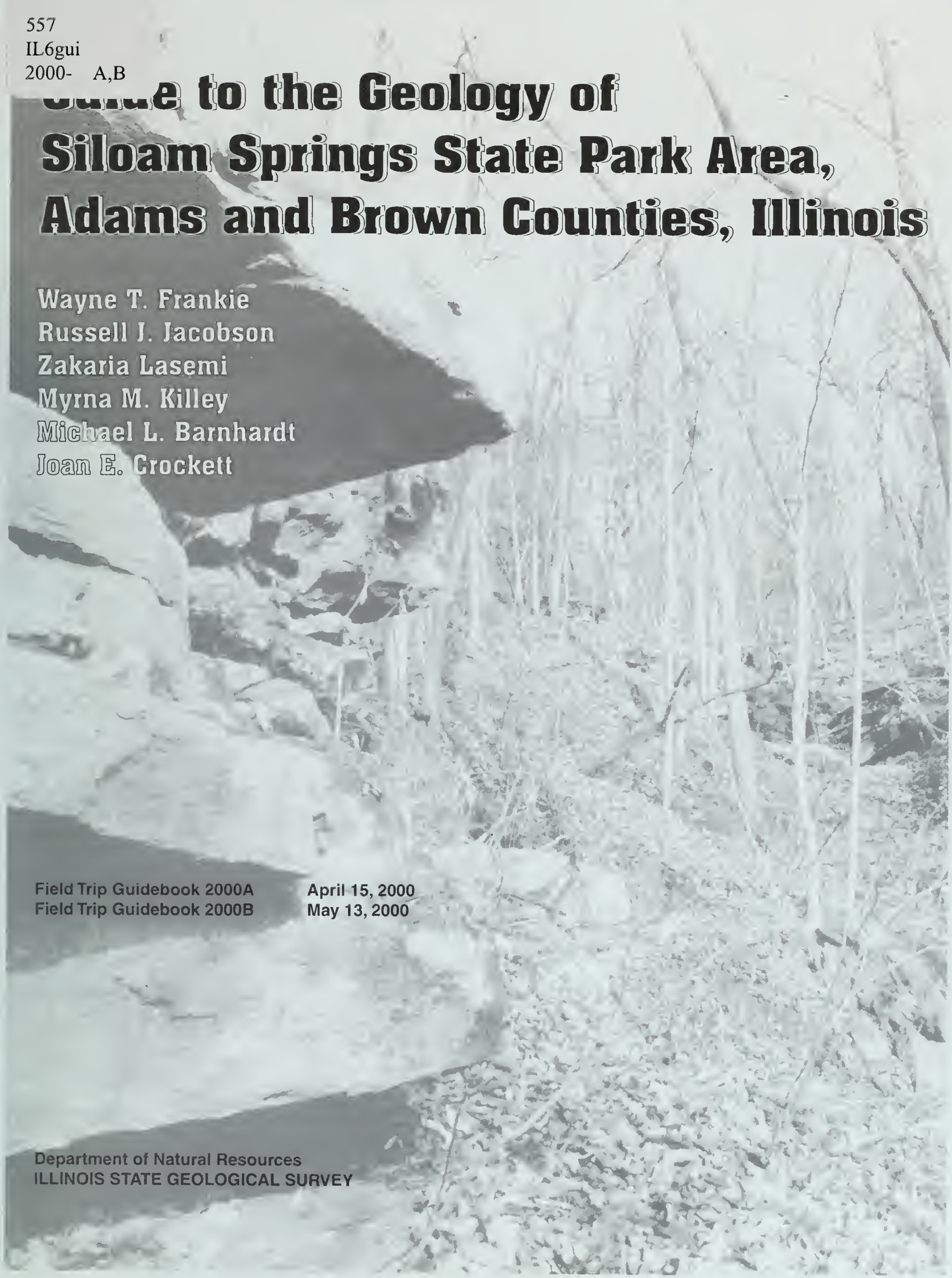


# Guide to the Geology of Siloam Springs State Park Area, Adams and Brown Counties, Illinois

Wayne T. Frankie
Russell J. Jacobson
Zakaria Lasemi
Myrna M. Killey
Michael L. Barnhardt
Joan E. Crockett

Field Trip Guidebook 2000A April 15, 2000
Field Trip Guidebook 2000B May 13, 2000

Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY

# Guide to the Geology of Siloam Springs State Park Area, Adams and Brown Counties, Illinois

Wayne T. Frankie
Russell J. Jacobson
Zakaria Lasemi
Myrna M. Killey
Michael L. Barnhardt
Joan E. Crockett

Field Trip Guidebook 2000A April 15, 2000
Field Trip Guidebook 2000B May 13, 2000

Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY

*Cover photo Warsaw Formation, view from bluffs, south of spillway and above Crabapple Creek at Stop1 (photo by W. T. Frankie)*

**Geological Science Field Trips** The Geoscience Education and Outreach Unit of the Illinois State Geological Survey (ISGS) conducts four free tours each year to acquaint the public with the rocks, mineral resources, and landscapes of various regions of the state and the geological processes that have led to their origin. Each trip is an all-day excursion through one or more Illinois county. Frequent stops are made to explore interesting phenomena, explain the processes that shape our environment, discuss principles of earth science, and collect rocks and fossils. People of all ages and interests are welcome. The trips are especially helpful to teachers who prepare earth science units. Grade school students are welcome, but each must be accompanied by a parent or guardian. High school science classes should be supervised by at least one adult for each ten students.

A list of guidebooks of earlier field trips for planning class tours and private outings may be obtained by contacting the Geoscience Education and Outreach Unit, Illinois State Geological Survey, Natural Resources Building, 615 East Peabody Drive, Champaign, IL 61820-6964. Telephone: (217) 244-2427 or 333-4747. This information is on the ISGS home page: http://www.isgs.uiuc.edu

Four USGS 7.5-Minute Quadrangle maps (Fishhook, Kellerville, Mt. Sterling, and Perry West) provide coverage for this field trip area.



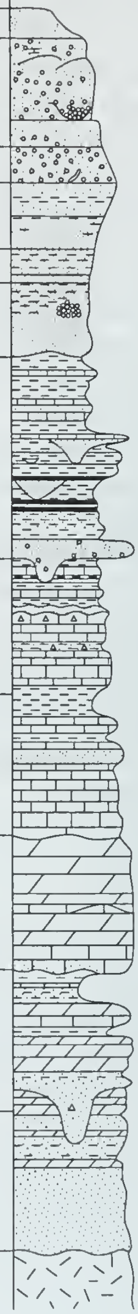
Printed with soybean ink on recycled paper

printed by authority of the state of Illinois/2000/900

**CONTENTS**


| | |
|---|---|
| SILOAM SPRINGS STATE PARK AREA | 1 |
| Geologic Framework | 1 |
| Precambrian Era | 1 |
| Paleozoic Era | 2 |
| Depositional History | 2 |
| Paleozoic Era | 4 |
| Structural Setting | 5 |
| Stratigraphy | 7 |
| Paleozoic Era | 7 |
| Mesozoic Era | 10 |
| Cenozoic Era | 13 |
| Geomorphology | 19 |
| Physiography | 19 |
| Natural Divisions and Geology | 21 |
| Natural Divisions | 21 |
| Drainage | 22 |
| Relief | 22 |
| Natural Resources | 22 |
| Clay Resources | 22 |
| Coal Resources | 23 |
| Oil and Gas Resources | 23 |
| Limestone Resources | 25 |
| Mineral Production | 26 |
| Groundwater | 27 |
| Siloam Springs State Park | 27 |
| History | 27 |
| Recreation | 28 |
| GUIDE TO THE ROUTE | 30 |
| STOP DESCRIPTIONS | 45 |
| 1 Crabapple Lake – Auxiliary Spillway | 45 |
| 2 Siloam Springs Picnic Area | 47 |
| A. Mineral Springs | 47 |
| B. Exposure of Glacial Deposits | 47 |
| 3 Buckhorn Oil Field | 49 |
| Oil and Gas Production in Western Illinois | 49 |
| 4 Little Missouri and McKee Creeks | 51 |
| 5 Lunch: Siloam Springs State Park – Main Shelter House | 52 |
| Geologic Maps – How They Help Society | 52 |
| Map Scales | 53 |
| 6 Lanes Branch – Left Fork | 54 |
| 7 Fishhook Creek | 55 |
| APPENDIX | 57 |
| REFERENCES | 60 |
| GLOSSARY | 62 |
| SUPPLEMENTARY READINGS | |

| Era | | Period or System and Thickness | Epoch | Age (years ago) | General Types of Rocks |
|---|---|---|---|---|---|
| CENOZOIC "Recent Life" | Age of Mammals | Quaternary 0-500' | Holocene | 10,000 | Recent– alluvium in river valleys |
| | | | Pleistocene Glacial Age | 1.6 m | Glacial till, glacial outwash, gravel, sand, silt, lake deposits of clay and silt, loess and sand dunes; covers nearly all of state except north-west corner and southern tip |
| | | Tertiary 0-500' | Pliocene | [ 5.3 m<br>36.6 m ] | Chert gravel, present in northern, southern and western Illinois |
| | | | Eocene | 57.8 m | Mostly micaceous sand with some silt and clay; presently only in southern Illinois |
| | | | Paleocene | 66.4 m | Mostly clay, little sand; present only in southern Illinois |
| MESOZOIC "Middle Life" | Age of Reptiles | Cretaceous 0-300' | | [ 144 m<br>286 m ] | Mostly sand, some thin beds of clay, and, locally, gravel, present only in southern Illinois |
| PALEOZOIC "Ancient Life" | Age of Amphibians and Early Plants | Pennsylvanian 0-3,000' ("Coal Measures") | | 320 m | Largely shale and sandstone with beds of coal, limestone, and clay |
| | | Mississippian 0-3,500' | | 360 m | Black and gray shale at base, middle zone of thick limestone that grades to siltstone chert, and shale; upper zone of interbedded sandstone, shale, and limestone |
| | Age of Fishes | Devonian 0-1,500' | | 408 m | Thick limestone, minor sandstones and shales; largely chert and cherty limestone in southern Illinois; black shale at top |
| | Age of Invertebrates | Silurian 0-1,000' | | 438 m | Principally dolomite and limestone |
| | | Ordovician 500-2,000' | | 505 m | Largely dolomite and limestone but contains sandstone, shale, and siltstone formations |
| | | Cambrian 1,500-3,000' | | 570 m | Chiefly sandstones with some dolomite and shale; exposed only in small areas in north-central Illinois |
| | | Precambrian | | | Igneous and metamorphic rocks; known in Illinois only from deep wells |



Generalized geologic column showing succession of rocks in Illinois.

# Siloam Springs State Park Area

The Siloam Springs State Park Area geological science field trip will acquaint you with the *geology**, landscape, and mineral resources for parts of Adams and Brown Counties, Illinois. Siloam Springs State Park, in west-central Illinois, is located 25 miles east of Quincy, along the border between Adams and Brown Counties. It is approximately 280 miles southwest of Chicago, 80 miles west of Springfield, 140 miles north of East St. Louis, and 280 miles northwest of Cairo. Siloam Springs State Park is one of the most beautiful parks in Illinois, and because of its remote location, one of the state's best kept secrets.

Adams County, formed from Pike County, was established on January 13, 1825, 7 years after Illinois became a state. It was named for John Quincy Adams (1767–1848), the sixth president of the United States (1825–1829). Brown County, formed from Schuyler County, was established on February 1, 1839, 21 years after Illinois became a state. It was named for Jacob Brown (1775–1828), a brigadier general of the New York Volunteers during the early years of the War of 1812. By 1815, Brown was Commander-in-Chief of the Army. He received a gold medal for his actions at Chippewa, Erie, and Niagra. Adams and Brown Counties were originally part of the "military tract" of western Illinois (land set aside to be given as payment to volunteer soldiers in the War of 1812). A large portion of the land was granted to and settled by veterans of the War of 1812.

## GEOLOGIC FRAMEWORK

### Precambrian Era

Through several billion years of geologic time, the area surrounding Siloam Springs State Park has undergone many changes (see the rock succession column, facing page). The oldest rocks beneath the field trip area belong to the ancient Precambrian *basement complex*. We know relatively little about these rocks from direct observations because they are not exposed at the surface anywhere in Illinois. Only about 35 drill holes have reached deep enough for geologists to collect samples from Precambrian rocks of Illinois. From these samples, however, we know that these ancient rocks consist mostly of granitic and rhyolitic *igneous*, and possibly *metamorphic*, crystalline rocks formed about 1.5 to 1.0 billion years ago. From about 1 billion to about 0.6 billion years ago, these Precambrian rocks were exposed at the surface. During this long period, the rocks were deeply weathered and eroded, and formed a barren landscape that was probably quite similar to the topography of the present Missouri Ozarks. We have no rock record in Illinois for the long interval of *weathering* and erosion that lasted from the time the Precambrian rocks were formed until the first Cambrian-age *sediments* accumulated, but that interval is almost as long as the time from the beginning of the Cambrian Period to the present.

Because geologists cannot see the Precambrian basement rocks in Illinois except as cuttings and cores from boreholes, they must use various other techniques, such as measurements of Earth's gravitational and magnetic fields, and seismic exploration, to map out the regional characteristics of the basement complex. The evidence indicates that in southernmost Illinois, near what is now the historic Kentucky–Illinois Fluorspar Mining District, *rift* valleys like those in east Africa

---

* Words in italics are defined in the glossary at the back of the guidebook. Also please note: although all present localities have only recently appeared within the geologic time frame, we use the present geographical names of places for geologic features because they provide clear reference points for describing the ancient landscape.

formed as movement of crustal plates (plate *tectonics*) began to rip apart the Precambrian North American continent. These rift valleys in the midcontinent region are referred to as the Rough Creek Graben and the Reelfoot Rift (fig. 1).

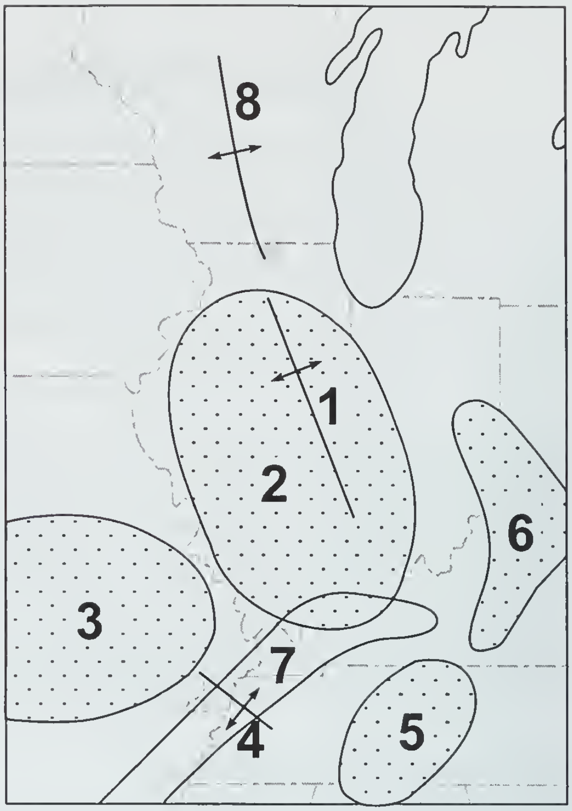



Figure 1 Location of some of the major structures in the Illinois region. (1) La Salle Anticlinorium, (2) Illinois Basin, (3) Ozark Dome, (4) Pascola Arch, (5) Nashville Dome, (6) Cincinnati Arch, (7) Rough Creek Graben–Reelfoot Rift, and (8) Wisconsin Arch.

## Paleozoic Era

After the beginning of the Paleozoic Era, about 520 million years ago in the late Cambrian Period, the rifting stopped and the hilly Precambrian landscape began to sink slowly on a broad regional scale, allowing the invasion of a shallow sea from the south and southwest. During the 280 million years of the Paleozoic Era, the area that is now called the Illinois Basin continued to accumulate sediments that were deposited in the shallow seas that repeatedly covered this subsiding basin. The region continued to sink until at least 15,000 feet of sedimentary strata were deposited. At various times during this era, the seas withdrew and the deposits were weathered and eroded. As a result, there are some gaps in the sedimentary record in Illinois.

In the field trip area, Paleozoic *bedrock* strata range in age from more than 520 million years old (the Cambrian *Period*) to less than 320 million years old (the Pennsylvanian Period). Figure 2 shows the succession of rock strata a drill bit would penetrate in this area if the rock record were complete and all the *formations* were present.

The elevation of the top of the Precambrian basement rocks within the field trip area ranges from 2,500 feet below sea level in southeastern Adams County to 3,000 feet below sea level in southeastern Brown County. The thickness of the Paleozoic sedimentary strata deposited on top of the Precambrian basement ranges from about 3,200 feet in southeastern Adams County to about 3,500 feet in southeastern Brown County.

# DEPOSITIONAL HISTORY

As noted previously, the Rough Creek Graben and the Reelfoot Rift (figs. 1 and 3) were formed by tectonic activity that began in the latter part of the Precambrian Era and continued until the Late Cambrian. Toward the end of the Cambrian, rifting ended and the whole region began to subside, allowing shallow seas to cover the land.

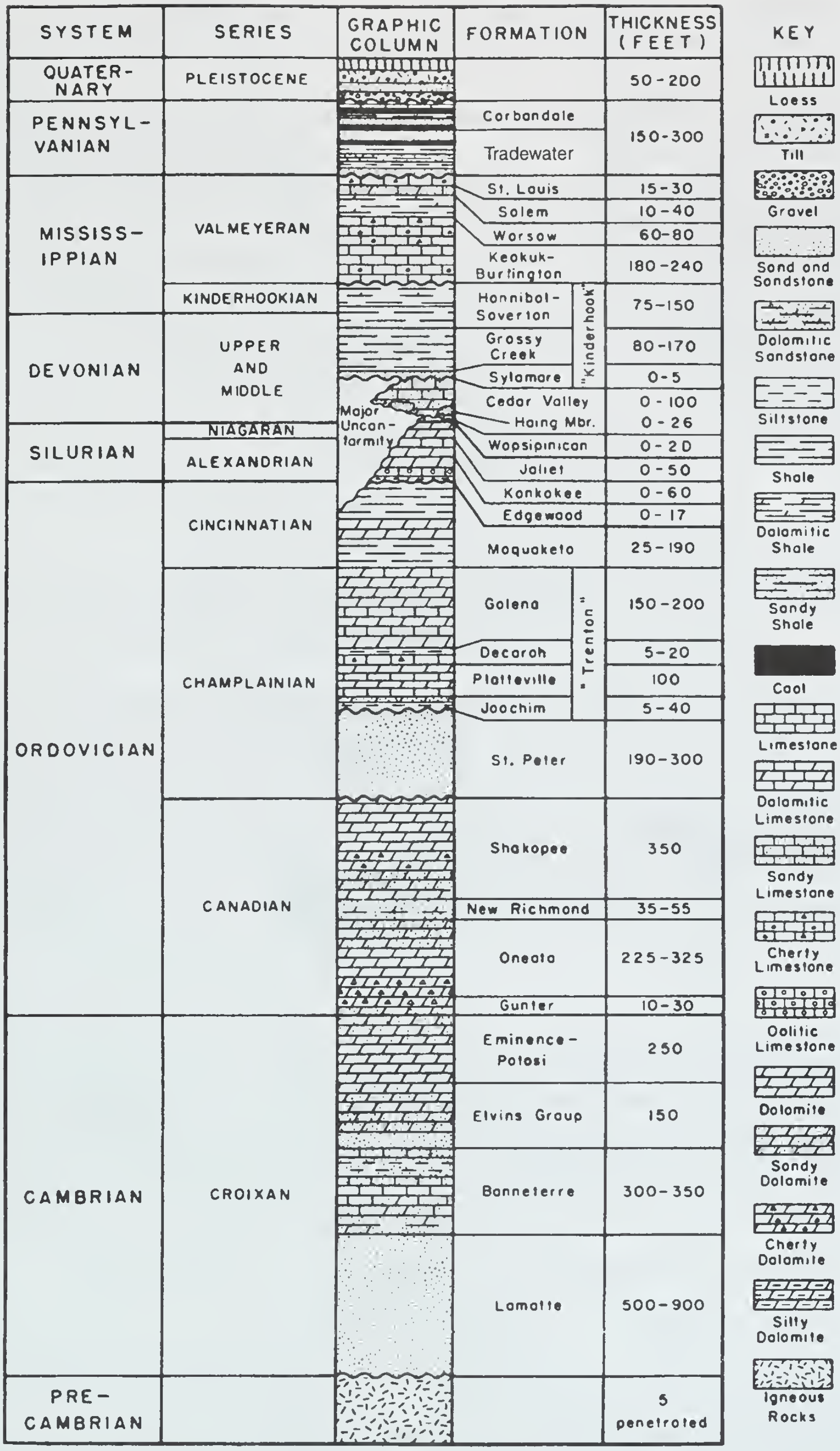



**Figure 2** Generalized stratigraphic column for Adams and Brown Counties; not to vertical scale (modified from Howard 1961).

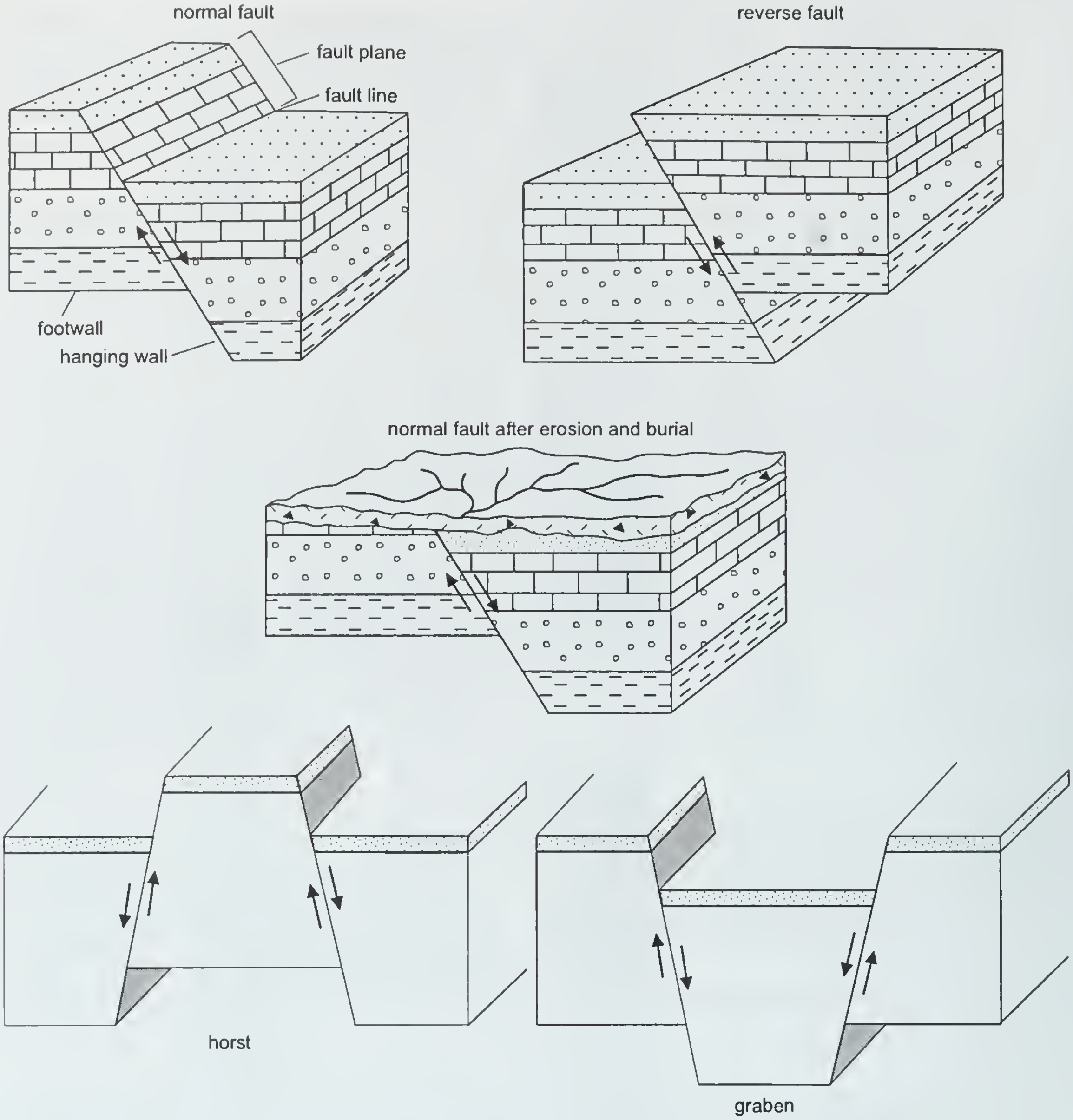



**Figure 3** Diagrammatic illustrations of fault types that may be present in the field trip area.

## Paleozoic Era

From the Late Cambrian to the end of the Paleozoic Era, sediments continued to accumulate in the shallow seas that repeatedly covered Illinois and adjacent states. These inland seas connected with the open ocean to the south during much of the Paleozoic, and the area that is now southern Illinois was like an embayment. The southern part of Illinois and adjacent parts of Indiana and Kentucky sank more rapidly than the areas to the north, allowing a greater thickness of sediment to accumulate there. During the Paleozoic and Mesozoic Eras, the Earth's thin crust was periodically flexed and warped in places as stresses built up in response to the tectonic forces associated with the collision of continental and oceanic plates (mountain building). These movements caused

repeated invasions and withdrawals of the seas across the region. The former sea floors were thus periodically exposed to erosion, which removed some sediments from the rock record.

Many of the sedimentary rock units, called formations, have conformable contacts—that is, no significant interruption in deposition occurred as one formation was succeeded by another (figs. 2 and 4). In some instances, even though the composition and appearance of the rocks change significantly at the contact between two formations, the *fossils* in the rocks and the relationships between the rocks at the contact indicate that deposition was virtually continuous. In contrast however, in some places, the top of the lower formation was at least partially eroded before deposition of the next formation began. In these instances, fossils and/or other evidence within or at the boundary between the two formations indicate that there is a significant age difference between the lower unit and the overlying unit. This type of contact is called an *unconformity* (fig. 4). If the *beds* above and below an unconformity are parallel, the unconformity is called a *disconformity.* However, if the lower beds were tilted and eroded prior to deposition of overlying beds, the contact is called an angular unconformity.

Unconformities occur throughout the Paleozoic rock record and are shown in the generalized stratigraphic column in figure 2 as wavy lines in the graphic column. Each unconformity represents an extended interval of time for which there is no rock record.

Near the close of the Mississippian Period, gentle arching of the rocks in eastern Illinois initiated the development of the La Salle Anticlinorium (figs. 1 and 5). This is a complex structure having smaller structures such as domes, *anticlines*, and *synclines* superimposed on the broad upwarp of the anticlinorium. Further gradual arching continued through the Pennsylvanian Period. Because the youngest Pennsylvanian strata are absent from the area of the anticlinorium (either because they were not deposited or because they were eroded), we cannot determine just when folding ceased—perhaps by the end of the Pennsylvanian or during the Permian Period a little later, near the close of the Paleozoic Era.

## STRUCTURAL SETTING

The Siloam Springs State Park field trip area in southeastern Adams and southwestern Brown Counties is located high on the northwest edge of the Illinois Basin. The Illinois Basin is the major structural depression between the Ozark Dome and the Cincinnati Arch (fig. 1). The field trip area is located a few miles east of the crest on the eastern flank of the north–south-trending Mississippi River Arch (fig. 5). The regional dip averages 8 feet per mile to the east (Howard 1961), but local

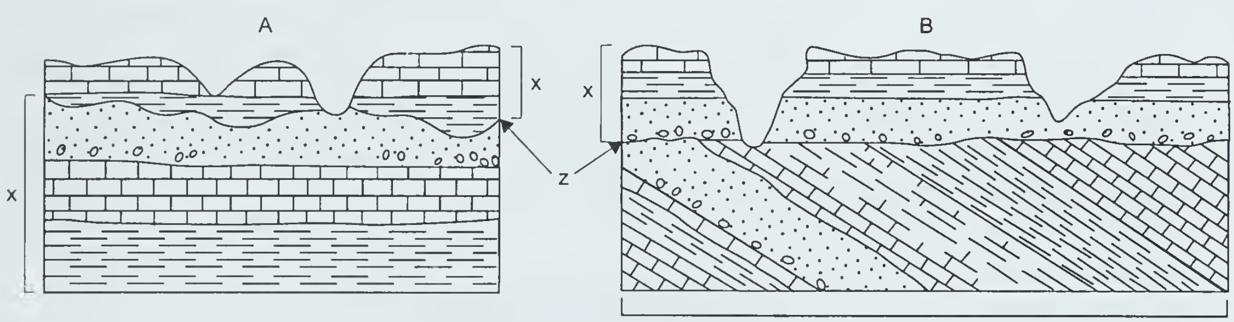



**Figure 4** Schematic drawings of (A) a disconformity and (B) an angular unconformity (x represents the conformable rock sequence and z is the plane of unconformity).

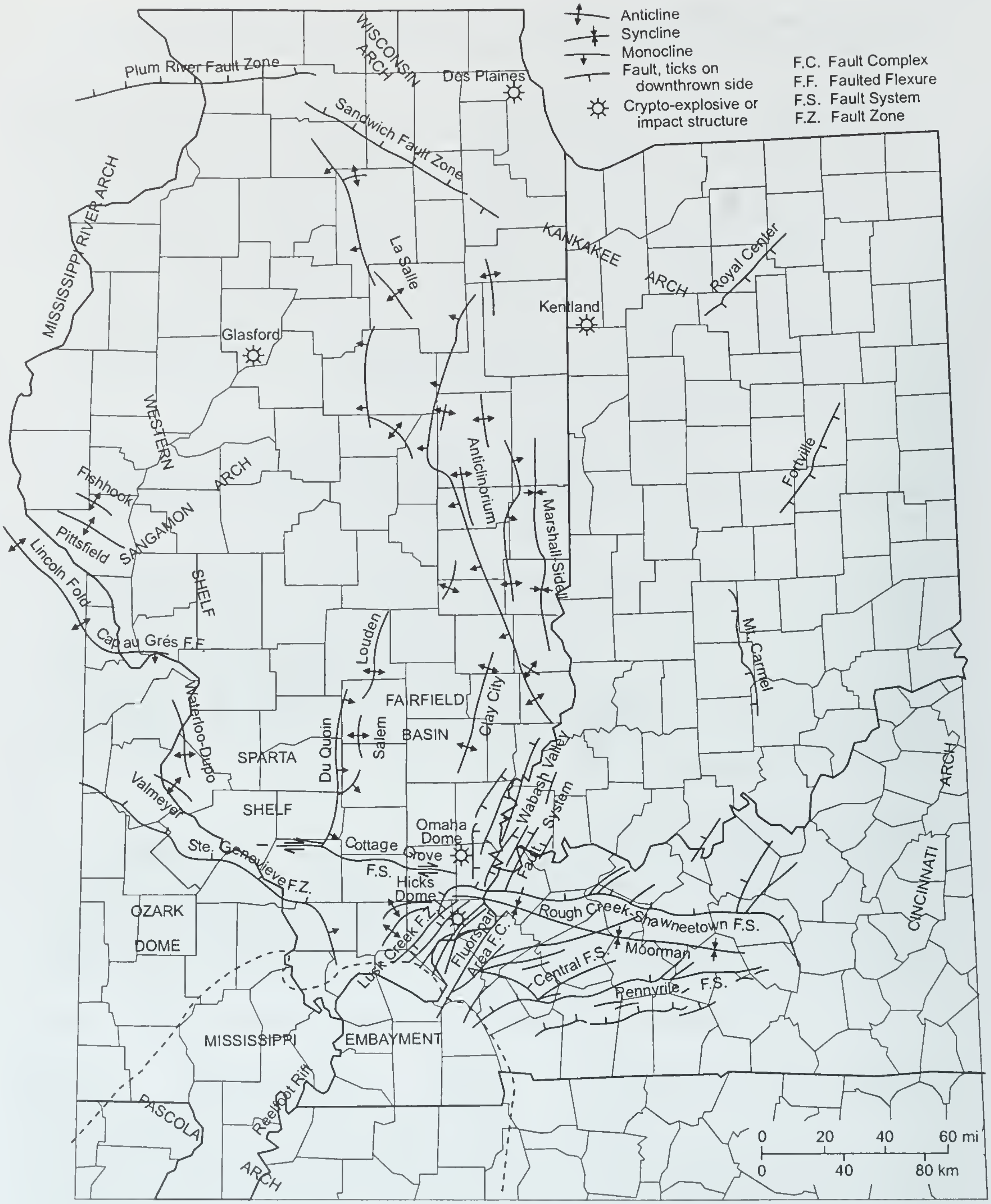



**Figure 5** Structural features of Illinois (modified from Buschbach and Kolata 1991).

flexures have produced structures that reverse or flatten this regional trend in places.

The Mississippi River Arch forms a structural divide between the Illinois and Forest City Basins (fig. 5). This arch trends slightly northeast–southwest, paralleling the Mississippi River in southeastern Iowa, northwestern Illinois, and northeastern Missouri. The present arch developed after the Morrowan (early Pennsylvanian) Epoch. An earlier arch existed in the same general area and was beveled by the sub-Kaskaskia (pre-Middle Devonian) unconformity (W. J. Nelson 1995).

The most prominent structural feature in the region that obscures the regional dip is the Fishhook Anticline (Meents 1958, Howard 1961, and Nelson 1993), which is about 30 miles long and as much as 5 miles wide, and trends northwest–southeast (figs. 5 and 6). Howard (1961) noted (on the basis of contours on the Galena) about 100 feet of closure on this structure with another 9 miles of structural nosing to the northwest. He found drill holes to the southeast that indicate that the trend of the structure continues to at least Griggsville. An irregular structural terrace occurs on the northeast flank of the Fishhook Anticline. This terrace is about 250 feet lower than the crest of the anticline and trends in the same east-southeast direction (see fig. 6). There is some closure with oil accumulation on the crest of this terrace (see Natural Resources section below) in what is known as the Kellerville and Siloam Oils Fields (fig. 6) (Meents 1958, Howard 1961).

Mapping of the bedrock surface in the Kellerville and Fishhook Quadrangles found exposures, of Pennsylvanian and Mississippian bedrock where the dip was essentially horizontal. However, examination of the trends of these units shows a general rise up and down the flanks of the Fishhook Anticline. A few local areas with dips between 3° and 5° to the northeast were measured on the northeast flank of the anticline (south center of Sec. 2, T3S, R5W, and Sec. 3, T3S, R5W, Adams County). The regional dip of strata is more readily seen in the distribution of bedrock exposures. The Mississippian strata in the field trip area slowly rise toward the Mississippi River Arch to the northwest, and the overlying Pennsylvanian rocks thin and pinch out or are removed by erosion. However, as the rocks descend into the Illinois Basin, the overlying Pennsylvanian units thicken and completely cover the Mississippian strata.

## STRATIGRAPHY

The following sections describe the rock units exposed in the field trip area and give some further details on how they were formed. The bedrock units are described first, from youngest to oldest (see fig 7).

## Paleozoic Era

### *Pennsylvanian Period*

**Carbondale Formation** (0 to 135 feet thick; see fig. 7) This unit consists of a thin coal at its base averaging 18 inches thick (Colchester Coal Member) that is directly overlain by 10 to 20 feet of black, fissile shale with limestone lenses and large concretions (Mecca Quarry Shale Member). The concretions contain marine fossils, including gastropods, bivalves, crinoids, and brachiopods. The remainder of the unit consists largely of siliciclastic lithologies, primarily blue-gray to gray, silty shale (Purington Shale Member) that grades upward locally to siltstone and sandstone. The sandstone (Pleasantview Sandstone Member) was deposited as a channel fill that locally is marked by tabular to irregular crossbeds. Sandstone in some locations displays well-laminated tidal bundles (alternating thin and thick beds) and grades laterally into an argillaceous, irregular, and clotted-textured limestone (Hanover Limestone Member). The limestone is characterized by gray to dark bluish gray limestone clasts in a light gray limestone matrix and contains marine fossils (such as

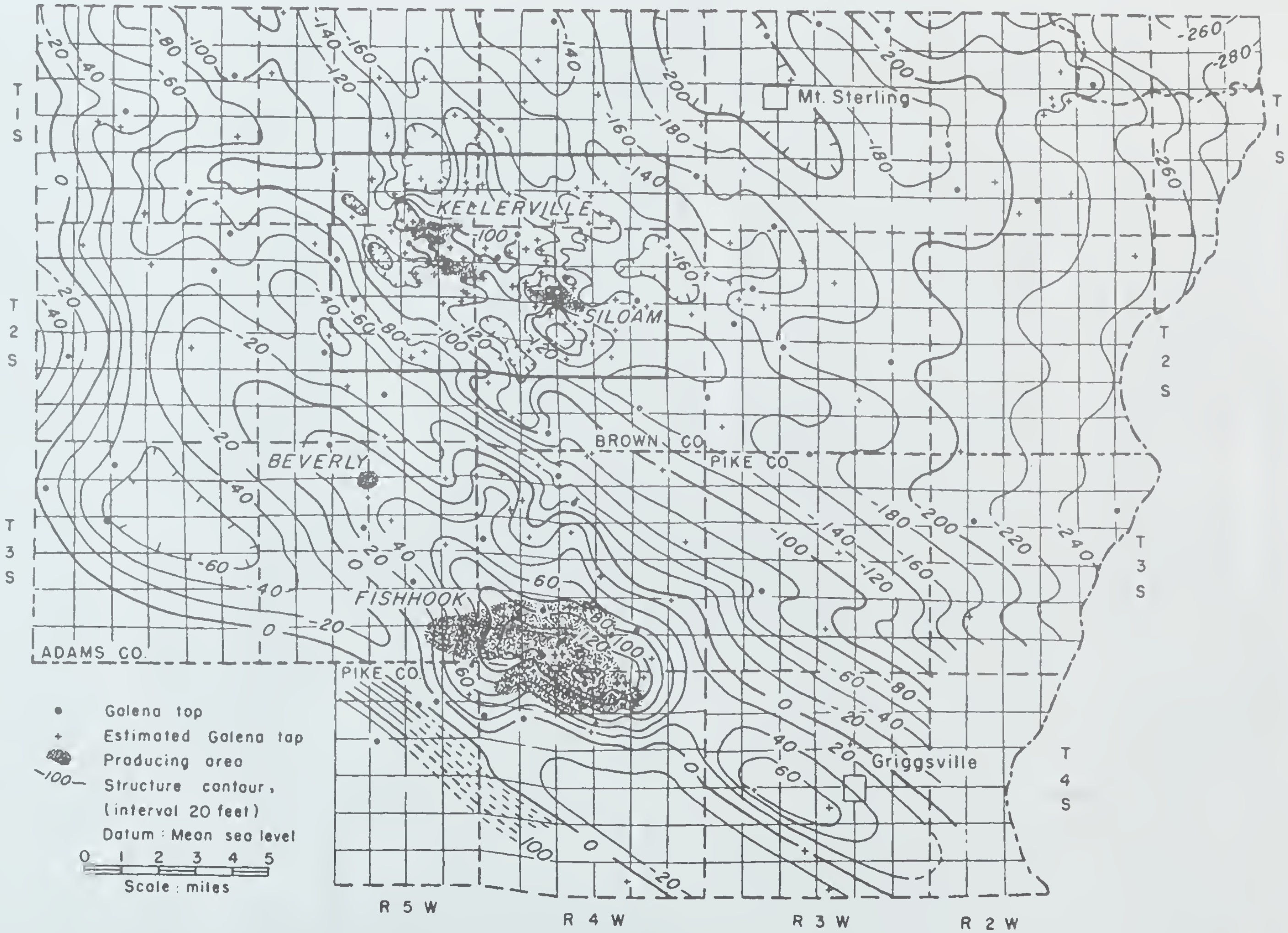



**Figure 6** Structure map on the top of the Ordovician-age Galena ("Trenton") Formation, showing location of the Fishhook Gas Field, and the Kellerville and Siloam Oil Fields (modified from Howard 1961).

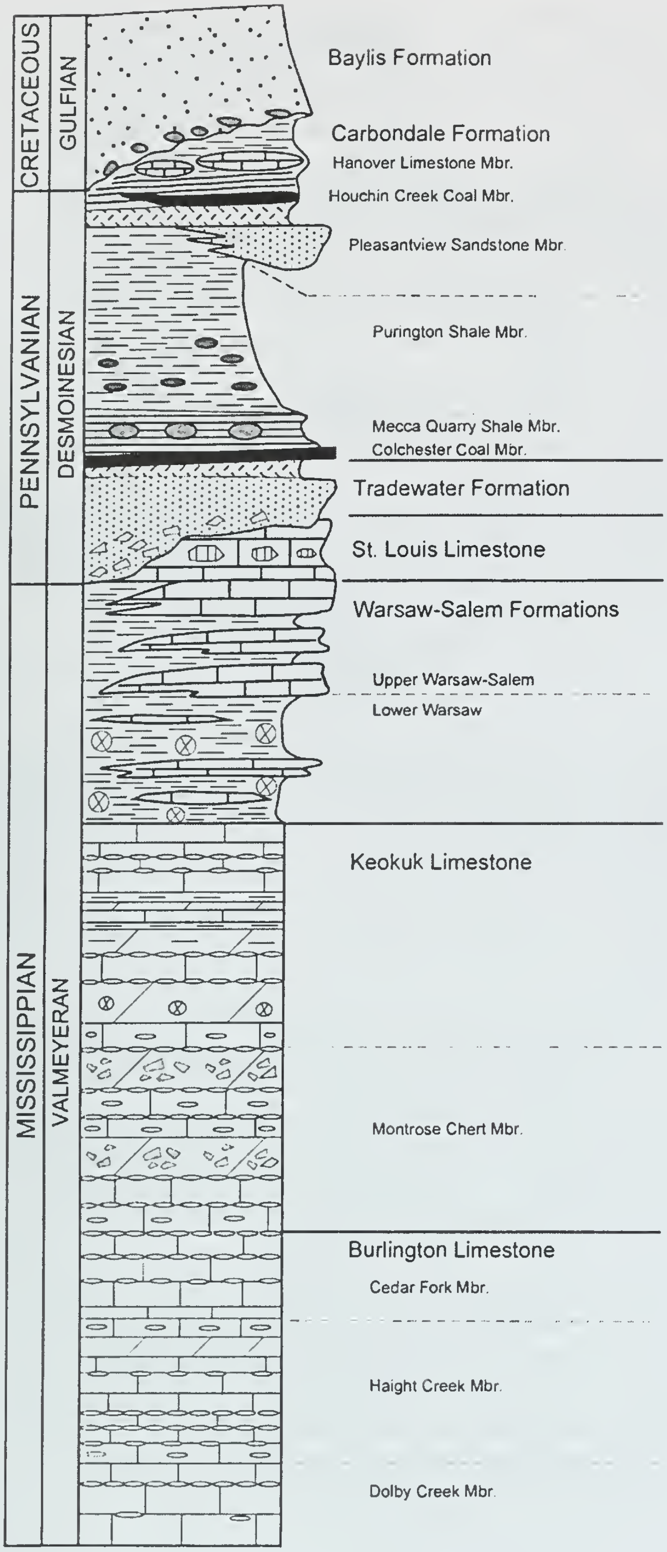



**Figure 7** Detailed stratigraphic column for the field trip area.

crinoids and brachiopods). Locally, a blackshale, shaley coal, and a thin claystone occur below this limestone and probably represent the Excello Shale Member, a poorly developed Houchin Creek Coal Member and the underlying claystone.

**Tradewater Formation** (0 to 15 feet thick, typically averaging 4–5 feet thick; see fig. 7) This unit consists of a light gray to whitish, rooted claystone that is slightly sandy and grades downward to thin, argillaceous sandstones. The unit contains fossil root casts, which suggest it was once part of an ancient soil. The sandstone laterally grades into thick channel fill deposits (paleochannels) that can be seen to cut downward into the underlying formations by as much as 30 feet. These paleochannel deposits occur on the irregular erosion surface that forms the unconformable contact between the Pennsylvanian rocks and the underlying rocks of the Mississippian System. The sandstone filling these channels is typically gray to light gray, quartzose, slightly argillaceous, medium to coarse grained and is crossbedded in many places. In the lower portions of the channel sandstones, a conglomeratic lag consisting of limestone and chert clasts is commonly present. This basal lag is a residuum that was formed by weathering and erosion of the underlying St. Louis Limestone and Warsaw Formations at the unconformity.

### *Mississippian Period*

**St. Louis Limestone** (0 to 40 feet thick; see fig. 7) This unit is missing over much of the field trip area because of the long period of erosion at the Pennsylvanian–Mississippian unconformity. Where present, the St. Louis occurs only as thin, irregular

patches. Only the lower portion of the St. Louis Limestone is preserved in the area, and it is best developed along Missouri Creek north of the center of Sec. 17, T2S, R4W, and along Walnut Creek in the eastern half of Sec. 5, T2S, R5W. The St. Louis consists of light gray to gray brown, microcrystalline limestone and dolomite that weathers yellow-gray to tan. Green shale beds occur in some intervals. Some beds are characterized by algal laminations (stromatolites) formed by sediment trapped and bound by the filaments of blue-green algae. The St. Louis contains some evaporites, such as gypsum and anhydrites, in the subsurface. In nearsurface and surface outcrops, the evaporite zones are typically represented by zones of brecciated (broken) rock that apparently formed when a layer of gypsum and/or anhydrite dissolved and the overlying limestone collapsed into the void. In a few outcrops, some remnant evaporites (or calcite pseudomorphs replacing the anhydrite) are present. The brecciated interval is commonly silicified. Scattered marine fossils are present; especially characteristic are the large, silicified coral heads *Acrocyathus* (probably *A. floriformis*) found in this formation, especially along Walnut Creek.

**Salem Limestone and Sonora Sandstone** In western Adams and Hancock Counties, the Salem Limestone and Sonora Sandstone (0 to 40 feet and 0 to 60 feet thick respectively; see figs. 2 and 7) lie between the St. Louis Limestone and the Warsaw Formation. Locally in the field trip area, a fine-grained, greenish gray, dolomitic sandstone or a white crinoidal grainstone containing foraminifera fossils caps the upper Warsaw carbonates. The sandstone may belong to the Sonora Sandstone. The crinoidal grainstone unit is lithologically similar to the Salem Limestone, the foraminifera are typical of the Salem, and it is likely that these beds are a thin facies of the Salem Limestone that caps the Warsaw carbonates in the field trip area. Because these units were very thin and discontinuous, it was not practical to map them separately, so they were just included in the Warsaw during the recent geologic mapping of the area.

**Warsaw Formation** (0 to 120 feet thick; see fig.7) This unit consists of light to medium gray or blue-gray shale interbedded with finely crystalline, argillaceous dolomite and light gray to olive gray (rusty to yellow-orange where weathered) fossiliferous limestones (grainstones). The limestone is locally dolomitic in part. Shale predominates in the lower part of the Warsaw, whereas limestone and dolomite dominate the upper part of the Warsaw. The Warsaw is quite fossiliferous; it includes abundant bryozoans and common brachiopods, gastropods, and echinoderms. While thin limestones (grainstones) are scattered throughout the unit, they develop in many places into one or more massive ledges in the upper part of the Warsaw, especially along portions of McKee Creek and Missouri Creek. Geodes are moderately abundant in the formation, especially in the middle, more shaley intervals and range from golf ball- to basketball-size specimens.

**Burlington–Keokuk Limestone** (180 to 255 feet thick; see fig. 7) This unit consists of light gray to buff, fine- to coarse-grained, fossiliferous limestones (grainstones), in beds ranging from a few inches to more than 2 feet thick. Dolomitic limestone beds occur in places. Some grainstone beds are separated by thin clay or shale partings. Nodular to lenticular masses of chert are abundant in some intervals. On the basis of drill hole data, it appears the Burlington–Keokuk only occurs beneath alluvial fill along McKee Creek in the southeastern part of the Kellerville Quadrangle. Farther south in the Fishhook Quadrangle, the Burlington–Keokuk is sporadically exposed along McKee Creek.

## Mesozoic Era

During the Mesozoic Era, the rise of the Pascola Arch (figs. 1 and 5) in southeastern Missouri and western Tennessee produced a structural barrier that helped form the current shape of the Illinois *Basin* by closing off the embayment that existed for most of the Paleozoic Era. The Pascola Arch

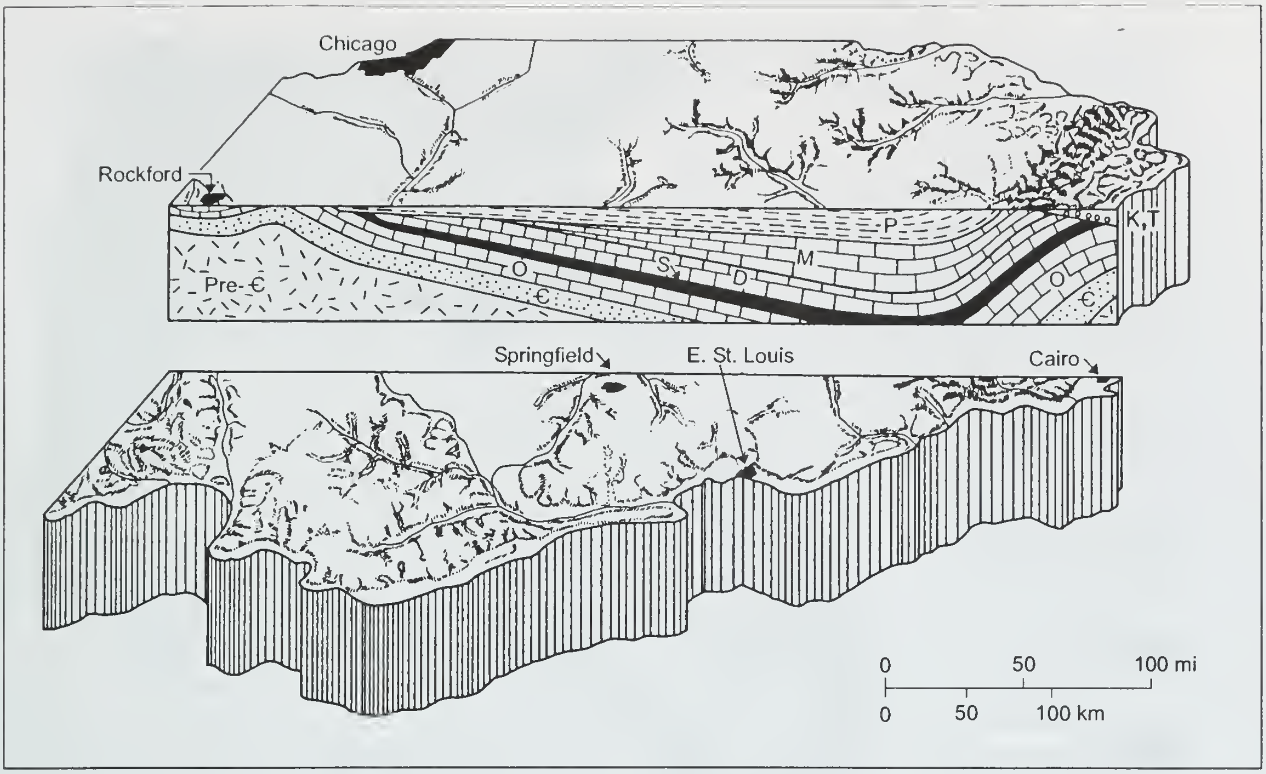



**Figure 8** Stylized north–south cross section showing the structure of the Illinois Basin. To show detail, the thickness of the sedimentary rocks has been greatly exaggerated, and younger, unconsolidated surface deposits have been eliminated. The oldest rocks are Precambrian (Pre-Є) granites. They form a depression filled with layers of sedimentary rocks of various ages: Cambrian (Є), Ordovician (O), Silurian (S), Devonian (D), Mississippian (M), Pennsylvanian (P), Cretaceous (K), and Tertiary (T). Scale is approximate.

physically separated the basin from the open sea to the south. The Illinois Basin is the broad, subsided and sediment-filled region covering much of Illinois, southwestern Indiana, and western Kentucky (fig. 1). Development of the Pascola Arch, in conjunction with the earlier sinking of the deeper portion of the basin to the north, gave the basin its present asymmetrical, spoon-shaped configuration (fig. 8). The tectonic uplifting of the Pascola Arch is responsible for the regional northward-dipping nature of the Paleozoic rocks along the southern portion of the Illinois Basin (see fig. 8). This uplifting of the Paleozoic rocks and subsequent erosion created the east–west escarpment of Mississippian- and Pennsylvanian-aged strata in southern Illinois. This escarpment forms the southern edge of the Illinois Basin. South of this escarpment, the deeply eroded Paleozoic rocks are overlain by Cretaceous- and Tertiary-age sediments (fig. 8), which were deposited in an area called the Mississippian Embayment (fig. 5). The geologic map (fig. 9) shows the distribution of the rock *systems* of the various geologic time periods as they would appear if all the glacial, windblown, and surface materials were removed.

Younger rocks of the latest Pennsylvanian and perhaps the Permian (the youngest rock systems of the Paleozoic) may at one time have covered the area of Adams and Brown County. Late Cretaceous-age sediments of the Mesozoic Era (see the generalized geologic column and fig. 9) were deposited within the field trip area and perhaps over an even larger area. These Late Cretaceous sediments occur along a prominent ridge that forms a drainage divide between the Illinois River and the Mississippi River drainage basins. This Cretaceous capped ridge trends southeast–north-

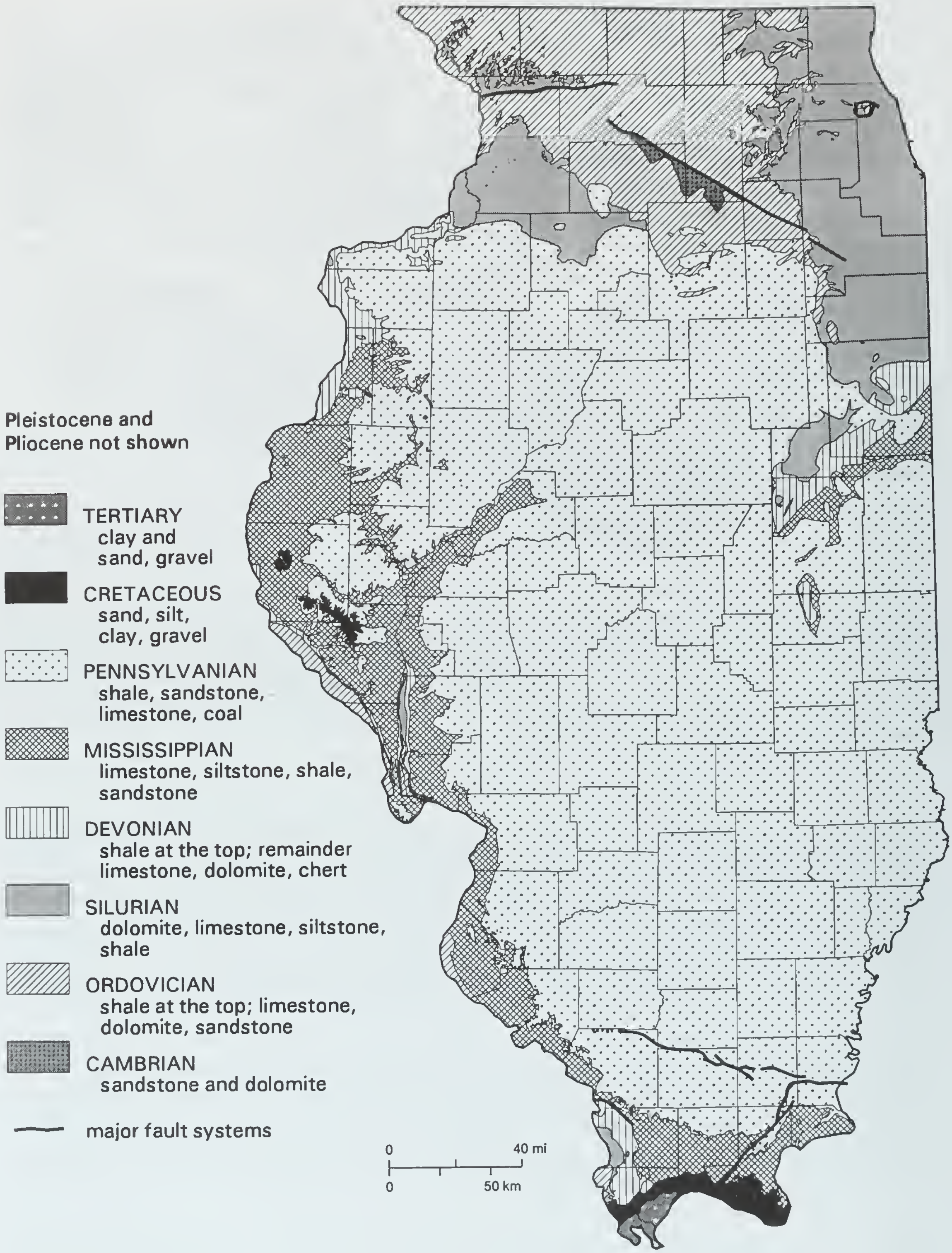



**Figure 9** Bedrock geology beneath surficial deposits in Illinois.

west, extending from the community of Baylis in Pike County, through Beverly, to the community of Payson in Adams County. A second small area of Cretaceous sediments is located northeast of Quincy near Mendon.

These Cretaceous sediments are known as the Baylis Formation (after Baylis, Pike County). Mapping on the Fishhook Quadrangle has shown the formation to be more patchy than indicated on previous maps, with significant weathering and local removal with replacement by pre-Illinois episode deposits. Exposures are also patchy in part because slopes are well rounded, slumped, and vegetated and often mantled by *loess*, soil, and glacial tills. The Baylis Formation (fig. 7) is made up predominantly of uncemented fine to medium quartz sand and clayey sand with zones of dispersed granules of angular white chert, lenses of silty clay, and in a few places moderately well rounded pebbles of chert, quartz, and quartzite. The sediments in this formation range from 0 to 40 feet thick. The unit typically is massive to thick with indistinct bedding. Some zones consist of relatively clean, well-sorted, medium to fine sands that are well bedded to crossbedded. Colors vary from white to light gray, tan, brown, and orange-brown, with the tan and brown often occurring as color bands and mottling of the gray colors. A few zones commonly contain fine micas, which are readily seen in outcrop. Sand mixed with rounded brownish chert and some quartz and quartzite pebbles may be found in the basal part up to 15 feet thick. This basal unit is known as the Hadley Gravel Member, while the predominant sandy and clayey overlying facies is called the Kiser Creek Member. The basal portion of the Hadley Gravel Member has an iron-stained zone, and in some parts of Adams County, it is highly cemented. The whole unit rests unconformably on Paleozoic bedrock in the area, usually on top of the Pennsylvanian-age Carbondale Formation, and a distinct weathered zone (a paleosol of reddish shale) can be seen at the top of this contact with the base of the Baylis Formation.

Indirect evidence, based on the stage of development (rank) of coal deposits and the generation and maturation of petroleum from source rocks elsewhere in Illinois (Damberger 1971), indicates that perhaps as much as an additional 7,000 feet of latest Pennsylvanian and younger rocks once covered southern Illinois. During the more than 240 million years since the end of the Paleozoic Era (and before the onset of *glaciation* 1 to 2 million years ago), however, several thousands of feet of strata may have been eroded. Nearly all traces of any post-Pennsylvanian bedrock that may have been present in Illinois were removed except in southern and western Illinois. During this extended period of erosion, deep valleys were carved into the gently tilted bedrock formations (fig. 10). Later, the topographic *relief* was reduced by repeated advances and melting back of continental *glaciers* that scoured and scraped the bedrock surface. This glacial erosion affected all the formations exposed at the bedrock surface in Illinois. The final melting of the glaciers left behind the non-lithified deposits in which our Modern Soil has developed.

## Cenozoic Era

### *Glacial History of Illinois*

A brief general history of glaciation in North America and a description of the deposits and landforms resulting from glaciers is given in *Pleistocene Glaciations in Illinois* at the back of the guidebook.

As stated above, the erosion that took place long before the glaciers advanced across the state left a network of deep valleys carved into the bedrock surface (fig. 10). The present topography of Illinois is significantly different from the topography of the preglacial bedrock surface.

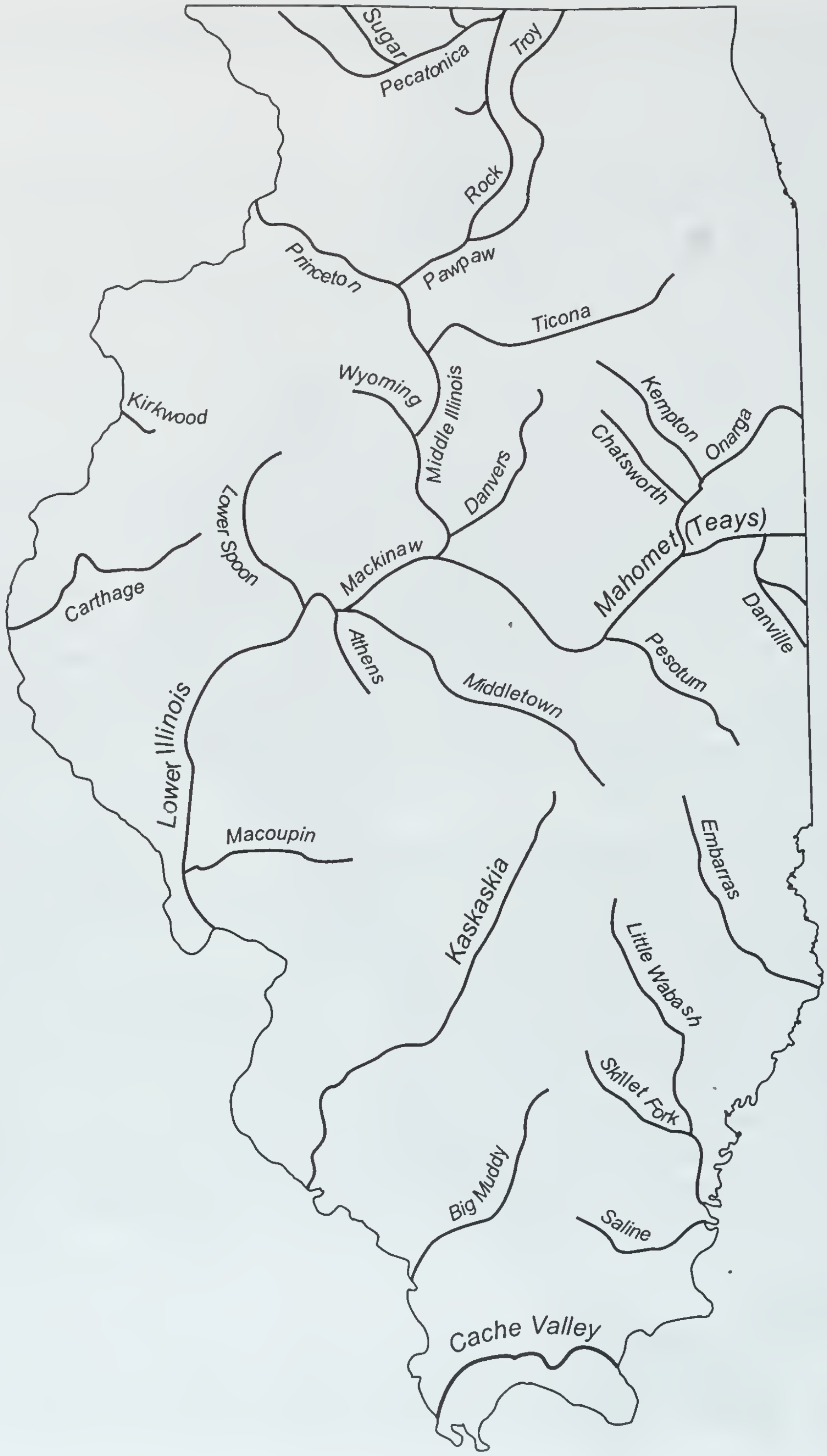



**Figure 10** Major bedrock valleys of Illinois.

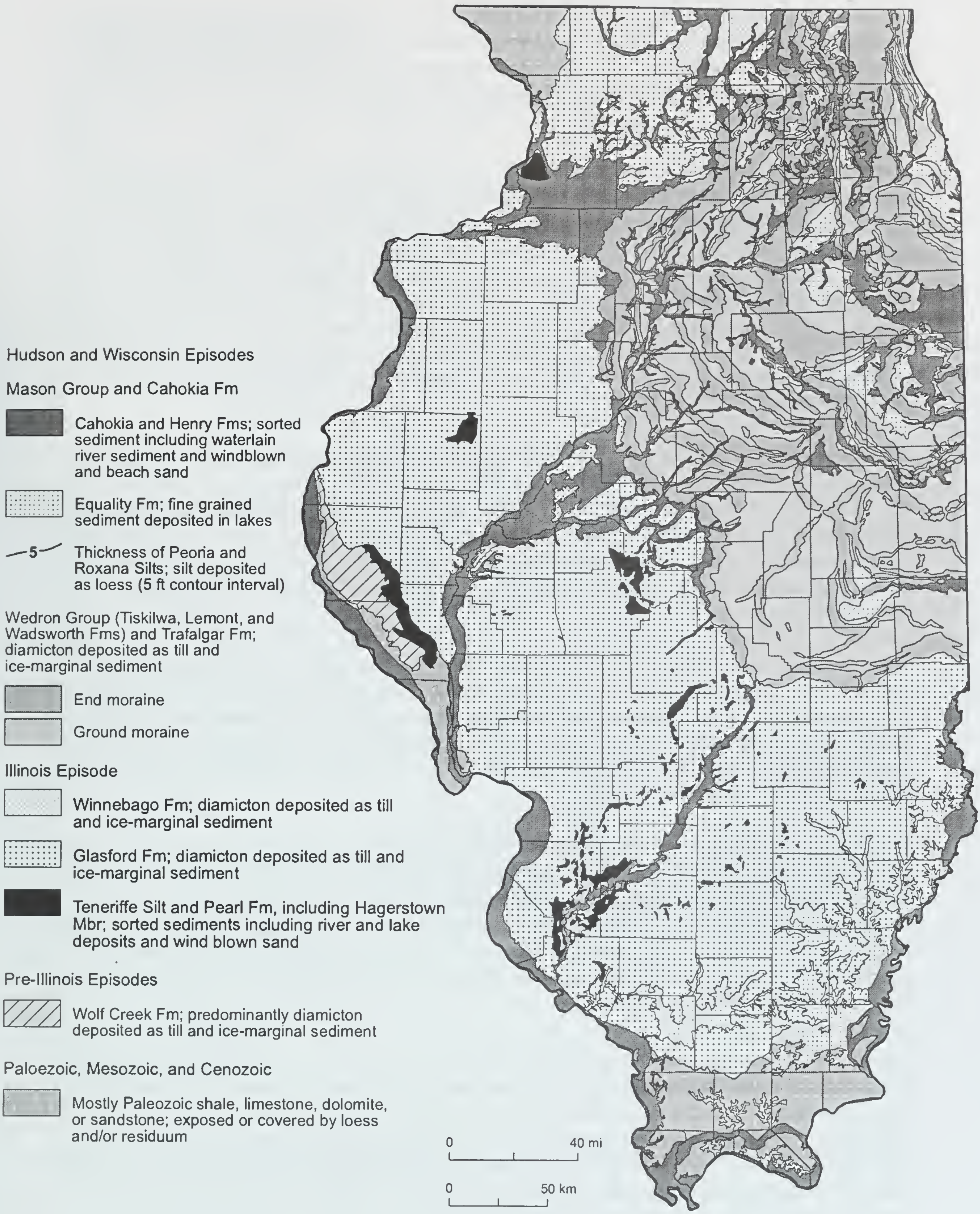



**Figure 11** Generalized map of glacial deposits in Illinois (modified from Willman and Frye 1970).

In the past 1.6 million to 2 million years—during the Pleistocene *Epoch* of the Quaternary Period—much of northern North America was repeatedly covered by huge glaciers (see fig. 11). These continent-size masses of ice formed in eastern and central Canada as a result of climate cooling. Their advances into the central lowland of the United States altered the landscape of much of the Midwest.

During an early part of the Pleistocene Epoch, glaciers advanced out of centers of ice accumulation both east and west of the Hudson Bay area in Canada. These centers are referred to in this guidebook as northeastern and northwestern source areas because Illinois lies to the south of and between these centers of accumulation. Glaciers flowing out of these centers into Illinois carried along rock debris incorporated into the ice as they advanced; the material was dropped out as the ice melted. The number and timing of these early episodes of glaciation are uncertain at present and are therefore unnamed; but because they precede the first named episode (the Illinois Episode; Hansel and Johnson 1996) of glaciation, they are called simply pre-Illinois glacial episodes. They are indicated by the number 1 on figure 12. The pre-Illinois glacial episodes ended about 425,000 years ago.

A long interglacial episode, called the Yarmouth, followed the last of the pre-Illinois glacial advances and is indicated by the number 2 on figure 12. The Yarmouth interglacial episode is estimated to have lasted approximately 125,000 years, and deep soil formation took place during that long interval (Yarmouth Geosol). On the parts of the landscape that were generally poorly drained, fine silts and clays slowly accumulated (accreted) in shallow, wet depressions and formed what are called accretion-gleys, which are characterized by dark gray to black, massive, and dense gleyed clays.

Approximately 300,000 years ago, the Illinois Episode of glaciation began. It lasted for about 175,000 years (number 3 on fig. 12), and during this interval, the ice advanced three times out of the northeastern center of accumulation. During the Illinois Episode, North American continental glaciers reached their southernmost position, approximately 250 miles south of here in the northern part of Johnson County (fig. 11). During the first of these advances, ice of this episode reached westward across Illinois and into Iowa.

Another long interglacial episode, called the Sangamon (number 4 on fig. 12), followed the Illinois Episode and lasted about 50,000 years. Although shorter than the Yarmouth interglacial episode, This interval's length was sufficient for another major soil, called the Sangamon Geosol, to develop. The Sangamon Geosol exhibits both well-drained and poorly drained soil profiles; although accretion-gleys are not as pronounced as they are in the Yarmouth Geosol, their occurrence is common across the Sangamon landscape, and they are easily identified by the same characteristics as the Yarmouth accretion-gleys.

About 75,000 years ago, the Wisconsin Episode of glaciation began. Ice from the early and middle parts of this episode (number 5 on fig. 12) did not reach into Illinois. Although late Wisconsin ice (number 6 on fig. 12) did advance across northeastern Illinois beginning about 25,000 years ago, it did not reach southern or western Illinois (fig. 11). The late Wisconsin glaciation is represented here only by the windblown silts (*loess*) that blanket the landscape and compose the parent materials for our modern soils. The maximum thickness of the later Wisconsin Episode glaciers was about 2,000 feet in the Lake Michigan basin, but only about 700 feet over most of the Illinois land surface (Clark et al. 1988). The last of these glaciers melted from northeastern Illinois about 13,500 years B.P.

| Years before present | Time-distance diagram Interglacial and glacial episodes | Sediment record | Dominant climate conditions Dominant land forming and soil forming events |
|---|---|---|---|
| HOLO-CENE | interglacial episode | River, lake, wind, and slope deposits. | Warm; stable landscape conditions. Formation of modern soil; running water, lake, wind, and slope processes. |
| PLEISTOCENE EPOCH (not to scale) 10,000 | WISCONSIN (late) glacial episode; glacial ice | Till and ice-marginal deposits; outwash and glacial lake deposits; loess. **6** | Cold; unstable landscape conditions. Glacial deposition, erosion, and landforming processes (e.g., formation of end moraines, outwash plains, valley trains, proglacial lakes, kettles), plus running water, lake, wind, and slope processes. |
| 25,000 | WISCONSIN (early and middle) glacial margin north of Illinois | Loess; river, lake, and slope deposits. **5** | Cool; stable. Weathering, soil formation (Farmdale Soil and minor soils); wind and running water processes. |
| 75,000 | SANGAMON interglacial episode | River, lake, wind, and slope deposits. **4** | Warm; stable. Weathering, soil formation (Sangamon Geosol); running water, lake, wind, and slope processes. |
| 125,000 | ILLINOIS glacial episode | Till and ice-marginal deposits; outwash and glacial lake deposits; loess. **3** | Cold; unstable. Glacial deposition, erosion, and landforming processes, plus proglacial running water, lake, wind, and slope processes; possible minor soil formation. |
| 300,000 | YARMOUTH interglacial episode | River, lake, wind, and slope deposits. **2** | Warm; stable. Long weathering interval with deep soil formation (Yarmouth Geosol); running water, lake, wind, and slope processes. |
| 425,000 – 1,600,000 and older | ? PRE-ILLINOIS glacial and ? interglacial episodes | Till and ice-marginal deposits; outwash and glacial lake deposits; loess plus nonglacial river, lake, wind, and slope deposits. **1** | Alternating stable and unstable intervals of uncertain duration. Glacial deposition, erosion, and landforming processes, plus proglacial and interglacial running water, lake, wind, and slope processes; interglacial weathering and soil formation. |

**Figure 12** Timetable of glacial and interglacial events, sediment record, and dominant climate conditions of the Ice Age in Illinois (modified from Killey 1998).

The glacial deposits in Adams and Brown Counties consist primarily of (1) *till* —pebbly clay, silt, and sand, deposited directly from melting glaciers; (2) *outwash*—mostly sand and gravel, deposited by the rapidly flowing meltwater rivers; (3) *lacustrine deposits*—silt and clay that settled out in quiet-water lakes and ponds; and (4) *loess*—windblown sand and silt.

The loess (pronounced "luss") that mantles the bedrock and glacial drift throughout the field trip area was laid down by the wind during all of the glacial episodes, from the earliest pre-Illinois glacial episode (approximately 1.6 million years ago) to the last glacial episode, the Wisconsin Episode (which occurred approximately 25,000 to 13,500 years ago). This yellowish brown silt occurs on the uplands throughout Adams and Brown Counties and mantles the glacial drift throughout the field trip area. The loess is generally between 6 and 9 feet thick, but the thickness increases to the west and east towards the Mississippi and Illinois Rivers. The loess, which covers most of Illinois, is up to 15 feet thick along the Illinois River Valley and is more than 50 feet thick along the east edge of the Mississippi River Valley.

### Glacial History of Siloam Springs State Park Area

The Siloam Springs State Park area occupies a particularly interesting position with regard to ice advances out of both the northeastern and northwestern Canadian centers of ice accumulation: the area contains deposits of *till* that represent advances from each center. (Geologists often use the word "diamicton" as a general term to describe any heterogeneous, unsorted, unbedded sediment without any implication about how the material was deposited.) In the western part of the area, the pre-Illinois episode is represented by till of the Wolf Creek Formation, and this unit may represent the farthest southeastward extent of an early glacial advance out of the northwestern center of ice accumulation (see figs. 11, 12, and 13). Accretion-gleys of the Yarmouth Geosol are also commonly found in the area. Till in the eastern part of the area is classified as the Glasford Formation and represents the farthest southwestward advance of ice during the Illinois Episode; this ice originated in the northeastern center of ice accumulation (see figs.11, 12, and 13). Several outcrops in the park as well as outside the park on the Kellerville and Fishhook Quadrangles reveal not only tills but also bedded silts and more massive sediments that were probably deposited in proglacial lakes immediately beyond the ice margins of the glaciers from both ice accumulation centers. In much of this part of western Illinois, the Yarmouth Geosol can be seen in outcrops that underlie younger sediments. The Yarmouth often appears as a heavy, dark gray to black silty clay, an accretion-gley of pre-Illinois episode age that is classified as the Lierle (pronounced "Lyre-ly") Clay Formation.

One complication in unraveling the puzzle of the glacial history of this area is the occurrence at a fairly high elevation of Cretaceous-age (late Mesozoic Era; about 70 million years old) clayey sands that can resemble some of the more massive non-till glacial deposits (see figs. 9 and 13). The elevation of the base of the Cretaceous rocks in western Illinois ranges from a basal contact with Pennsylvanian and Mississippian rocks at about 670 to 770 feet above present sea level, to the highest elevation of about 860 feet (Frye, Willman, and Glass 1964). According to Willman and others (1975), these deposits are "the easternmost outliers of Cretaceous sediments that formerly covered the region east of the Rocky Mountains and north of the Ozarks. . . . [They] appear to be beach and nearshore sediments deposited in the advancing Cretaceous sea."

Another complication is the heavily eroded landscape. On the one hand, the numerous deep gullies provide outcrops that aid in mapping the bedrock surface, bedrock lithology, and the overlying Cretaceous and glacial deposits. On the other hand, however, several levels of stream terraces seen in the tributaries to McKee Creek, Crabapple Creek, and Siloam Creek attest to multiple episodes of

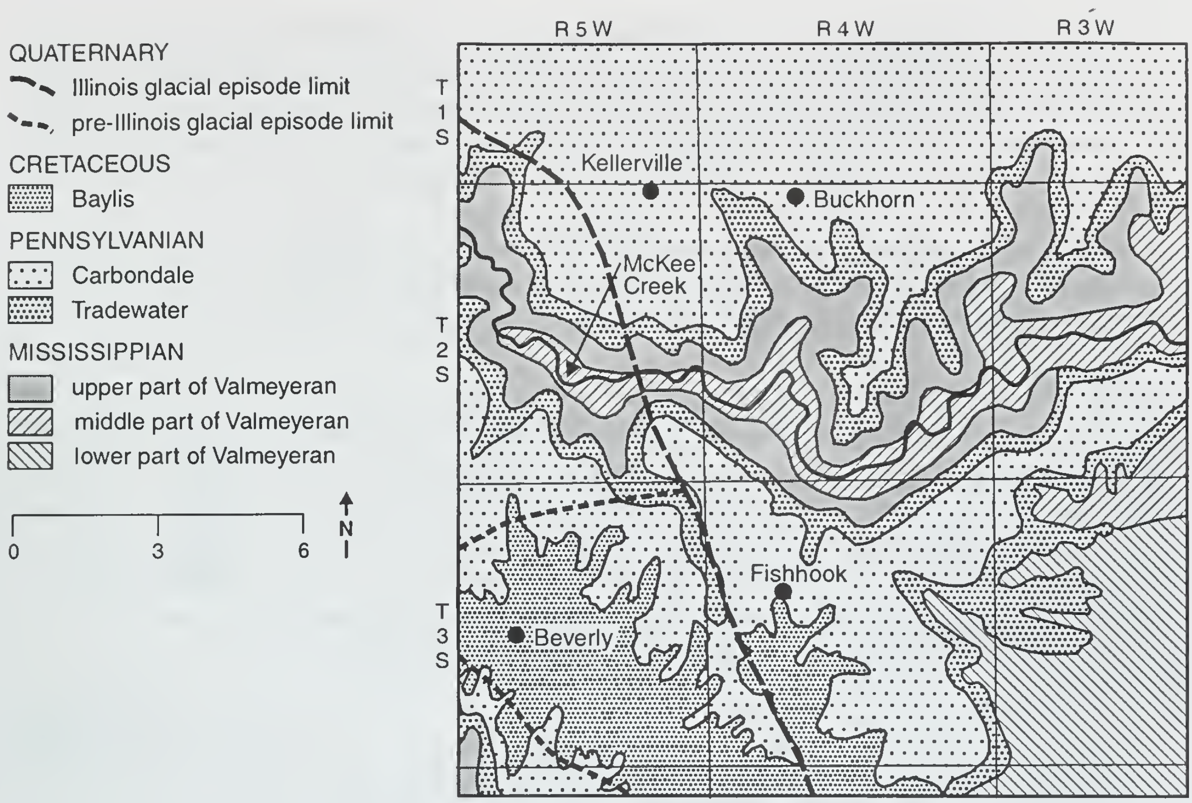



**Figure 13** Generalized geologic map of the bedrock formations in the field trip area, showing pre-Illinois and Illinois glacial episode limits. Flow path of the pre-Illinois glacier is from the northwest, and the flow path of the Illinois glacier is from the northeast.

erosion. In addition, the variability of the glacial sediments that can be seen in different outcrops on the Kellerville and Fishhook Quadrangles makes it a challenging puzzle to correlate the units from one outcrop to the next.

Altogether, the Siloam Springs area presents an appealing problem to geologists: it has a complex geological history with numerous clues to help sort it out, but enough uncertainty and complexity to create a real challenge that keeps us constantly alert to additional information that might afford new possible interpretations.

# GEOMORPHOLOGY

## Physiography

The field trip area is located in the southern end of the Galesburg Plain, a part of the *Till Plains* Section of the Central Lowland Physiographic Province (fig.14).

The Galesburg Plain, according to Leighton et al. (1948), includes the western segment of the Illinois Episode *drift* sheet, a level to undulatory plain with a few morainic ridges that was formed some 250,000 years ago, and is in a late youthful stage of erosion. It is bounded by Meredosia Valley and the Wisconsin drift border on the northeast, by the Illinois River Valley on the southeast, and by the Illinois Episode drift boundary on the southwest. On the northwest, the section continues across the Mississippi River into Iowa.

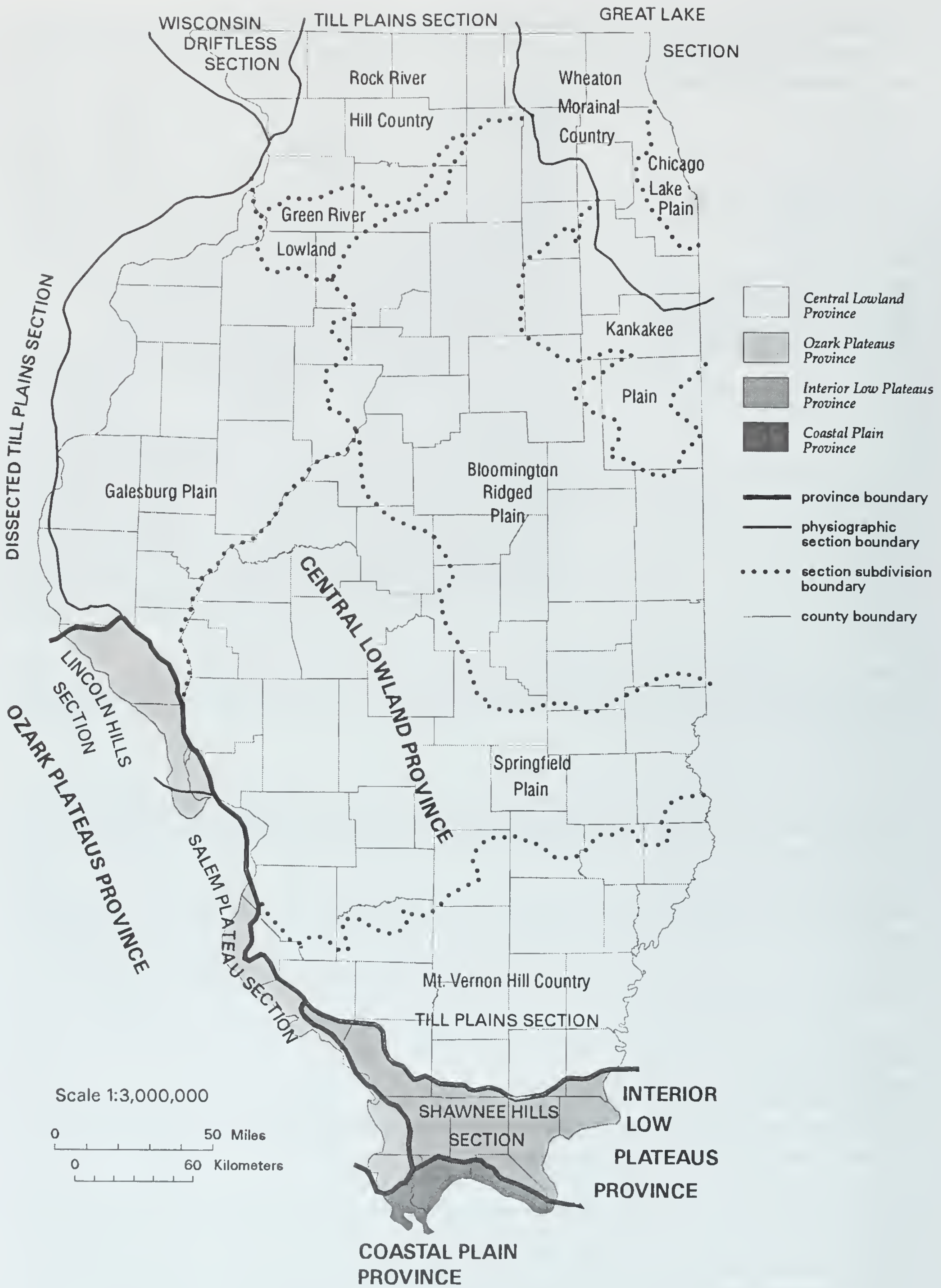



**Figure 14** Physiographic divisions of Illinois (from Leighton, Ekblaw, and Horberg 1948).

The Galesburg Plain is drained by streams that flow from a central upland westward into the Mississippi River and eastward and southward into the Illinois River. The larger valleys are steep walled, alluviated, and terraced, except for local narrowing along postglacial gorges. Much of the region is relatively high above the erosional baselevel, so that the minor valleys are numerous, deep, and have fairly steep gradients.

The Illinois Episode glacial drift is generally thick and is underlain by extensive pre-Illinois glacial episode deposits, especially along buried preglacial valleys. Most of the irregularities of the preglacial surface were filled in with older drift, so that only gross features of the bedrock topography are reflected in the present landscape.

## NATURAL DIVISIONS AND GEOLOGY

Glacial history played an important role in shaping Illinois' topography by eroding the preglacial landscape and depositing glacial sediments. Topography influences the diversity of plants and animals (biota) in Illinois by strongly influencing the diversity of habitats. Geological processes form, shape, and create the topography on all of Earth's surface. Specifically, geology not only determines the composition of the parent materials of soils, but geological processes form soils through the weathering of parent materials. Thus, the geology of a region is the foundation of its habitats.

### Natural Divisions

The state has been divided into 14 Natural Divisions. These divisions are distinguished according to differences in significant aspects of topography, glacial history, bedrock geology, soils, aquatic habitats, and distribution of plants and animals (flora and fauna). A strong relationship exists between the Physiographic Divisions and the Natural Divisions of Illinois because the geologic factors used to define the physiographic divisions were important elements used to define the boundaries of the Natural Divisions. Of the 14 Natural Divisions in Illinois, the field trip area is in the Galesburg Section of the Western Forest Prairie Division, and is located west of the Illinois River Valley.

The following description is modified from Schwegman (1973). The Western Forest Prairie Division is a strongly dissected glacial till plain formed in the Illinois and pre-Illinois glacial episode deposits. At the time of settlement, forest was the predominant vegetation, but there was also considerable prairie on the level uplands. The prairie soils were developed from loess and are fertile.

**Glacial History** – Most of the bedrock is covered by glacial drift from the Illinois Episode of Pleistocene glaciation. There is an area of older pre-Illinois episode glacial drift in the southwestern part of the Galesburg Section.

**Bedrock** – Pennsylvanian and Mississippian bedrock of limestone, sandstone, shale, and coal crop out in many places along the major streams.

**Topography** – The till plain is strongly dissected, with many ravines in the level to rolling uplands. Floodplains are developed along the major streams.

**Soils** – Most of the soils are fairly young, having developed in 4 to 5 feet of loess that blanket the region. The prairie soils are high in organic matter and are similar to those of the Grand Prairie Division. The forest soils are acidic and low in organic matter. Relatively small areas of droughty (dry), fine-textured soils have developed in till on some steep slopes.

## Drainage

Within the field trip area, drainage is controlled by McKee Creek and its tributaries, Fishhook Creek, Little Missouri Creek, Lanes Branch, and Siloam Creek. Drainage is eastward toward the Illinois River.

## Relief

The present landforms are a result of the glaciation during the pre-Illinois, Illinois, and Wisconsin glacial episodes and subsequent erosion by wind and rain. The highest land surface on the field trip route is located near the park office at Siloam Springs State Park, where the surface elevation is 760 feet above mean sea level (msl). The lowest elevation is about 520 feet above msl at Stop 4 along McKee Creek. The surface relief of the field trip area, calculated as the difference between the highest and lowest surfaces, is about 240 feet. *Local relief* is most pronounced along the bluffs adjacent to McKee Creek, where the tops of the adjacent bluffs loom up to 200 feet above the base elevation of the creek.

# NATURAL RESOURCES

The following detailed summary of mineral resources is compiled from the Illinois State Geological Survey geologic mapping initiative in the Kellerville and Fishhook Quadrangles.

## Clay Resources

Claystones present in the Tradewater Formation of the lower Pennsylvanian occur throughout much of the area. These beds of gray, fine-grained, non-laminated claystone range in thickness from a few feet to over 15 feet. They occur directly beneath the Colchester Coal and are equivalent to the much thicker Tradewater siliciclastic-dominated strata (shales, sandstones, as well as several limestones and coals) in the deeper parts of the Illinois Basin (see Reinertsen 1964, Willman et al. 1975). On the shelf area of the basin, where the Tradewater is very thin because of long periods of erosion or non-deposition, the claystone below the Colchester represents a paleosol that formed while the much thicker successions of Tradewater sediments were being deposited to the east and southeast in the Illinois Basin proper. The characteristics of this claystone (named Cheltenham Clay by Willman et al. 1975) are of potential interest in the production of a number of ceramic products.

Potential clay resources in the Kellerville Quadrangle are generally found just below the Colchester in a 5 to 15 foot interval between the coal and the base of the Pennsylvanian, which rests unconformably on the underlying Mississippian strata. To the east where the Tradewater is thicker, the claystone occurs between the Seahorne Limestone and Bernadotte Sandstone (absent in the field trip area). The basal part of the claystone is commonly sandy and grades laterally into a sandy claystone to a sandstone that thickens into 10- to 30-foot-deep channels that are cut into the underlying Mississippian strata along the irregular unconformity surface.

Referred to as "stoneware clays" by White (1963), these clays and some associated shales in this area are buff-burning (fire to cream to tan in color), and have a set of consistent physical properties that enhances their utility for making ceramics. He sampled this claystone interval just a mile to the west of the Kellerville Quadrangle (on the Liberty Quadrangle, NE, SW, NE, Sec.18, T2S, R5 W, Adams County) and found them to be largely of this character. The clays are suitable for manufacturing drain tile, flower pots, flue liners, pottery, sewer pipe, stoneware, structural clay products, and terra cotta and for use as fillers. Mapping of the Tradewater interval below the

Colchester Coal has revealed many occurrences of this claystone interval on the Kellerville Quadrangle. It is possible that some of these Tradewater claystones might yield commercial deposits.

White (1963) also noted that shales and clays in the remainder of the Carbondale Formation above the Colchester Coal on the quadrangle are all red-burning in character. Clays with high iron content turn red when fired because of the oxidation of the iron. These shales and clays could be used in the manufacture of a number of ceramic products, including drain tiles, flower pots, pottery, sewer pipes, and structural clay products (roof tile, etc.) (White 1963).

## Coal Resources

The Colchester Coal is the primary coal found and mapped in the southwest half of the Kellerville Quadrangle and the northeastern half of the Fishhook Quadrangle, where deep stream dissection and the slow rise of bedrock to the southwest have resulted in numerous exposures. The Colchester is quite thin, averaging about 18 inches in thickness. Although many small mines in the region have supplied coal for local consumption by farmers and landowners, there has been no large-scale coal mining in the immediate area. The Colchester Coal is overlain by a marine, black-shale roof (the Mecca Quarry Shale Member) and associated limestone beds (probably the Oak Grove Limestone Member). Therefore, it is expected that the sulfur values for the coal will be high (> 3%) due to sulfur contributed by the seawater that deposited the overlying marine rocks. Reinertsen (1964) reported a sulfur value of 3.9% for the Colchester Coal from a sample of the coal taken from a mine in Adams County. Because of environmental restrictions limiting use of high-sulfur coals, as well as economic factors favoring cheaper, low-sulfur western coal, it is unlikely that the thin Colchester Coal in the quadrangle will have much economic potential in the foreseeable future. In two small areas (north center of Sec. 34 and southwestern quarter of Sec. 26, T3S, R5W, Adams County), the Houchin Creek Coal is developed as a shaley coal roughly a foot or so thick beneath 3 feet of black, fissile Excello Shale. As with the Colchester, a number of small adits (tunnels) were noted where this poor-quality coal was mined for local consumption by farmers. The Houchin Creek here is so shaley as to blend in with the overlying black shale, and thus it is not likely ever to be considered a major resource because of its high ash content.

## Oil and Gas Resources

### *Fishhook Gas Field* (fig. 6)

Oil and gas accumulation on the Fishhook Quadrangle occurs along the trend of the Fishhook Anticline. The Fishhook Gas Field (south of Fishhook) was developed in March 1955 with the drilling of the discovery well on the Layne farm in the NE, NE, NE, Sec. 30, T3S, R4W, Pike County. This well was completed in the Silurian at a depth of 460 feet, with an open-flow gauge of 1,140,000 cubic feet of gas per day (Howard 1961). A total of 57 wells with open-flow gauges averaging 624,000 cubic feet per day was drilled in the Fishhook field, but all are now shut in due to market constraints. The pay zone occurs in 15 feet of sucrosic, vuggy dolomite of the Silurian Edgewood Formation. Meents (1955) tested nearly every well in this pool and reported several gas analyses as well as descriptions of core from the reservoir rocks.

The Beverly Gas field, is located 4 miles to the northwest and parallel to the trend of the Fishhook Anticline. The discovery well was drilled in February 1957, by the G and W Oil Company in the NW, NW, NW, Sec.10, T3S, R5W, Adams County, and had an open-flow gauge of 218,000 cubic feet of gas per year from the Silurian at a depth of 416 feet. The same company drilled the only other well in this field ¼ mile southwest of the discovery well with an open-flow gauge of 565,000 cubic feet per day. Both wells are now shut in like the wells in the Fishhook Field.

### *Kellerville Oil Field*

Oil and gas accumulation on the Kellerville Quadrangle occurs in a structural terrace on the northeast flank of the Fishhook Anticline. The discovery well of the Kellerville Oil Field (fig. 6) was drilled by Ray Starr in 1959 on the Wendell Doole farm in the NE, NE, NE, Sec.11, T2S, R5W, Adams County. The well was completed in porous Silurian dolomite at a depth of 639 feet with initial production of 3 barrels of oil per day.

The Kellerville field was extended 1.25 miles to the northeast in August (1959) by C. Arthur Beckman with the number 1, Pierce well drilled in the SE, SE, SW, Sec. 36, T1S, R5W. This well produced from the Silurian dolomite at a depth of 651 feet with an initial production of 10 barrels of oil and 80 barrels of water per day. Ray Starr drilled the number 1, C.A. Hendricks well in February 1960 in the NE, NE, NW, Sec. 2, T2S, R5W, which upon completion produced 200 barrels of oil per day from a depth of 639 feet in the Silurian. This extended the field 0.75 mile to the northwest. Further extensions of the Kellerville occurred at later dates.

By the end of 1960, the Kellerville had produced over 53,000 barrels of oil from 22 wells, of which about 51,000 barrels came from just four wells. Production from this field was about 24,000 barrels per year in the early 1960s (Howard 1961). By 1988, 81 wells were producing from the Kellerville field (Huff, 1988). As of 1988, production was averaging 4,100 barrels per year from the entire field (Huff 1988).

### *Siloam Oil Field* (fig. 6)

The Siloam Oil Field (T2S, R4W, Brown County) (fig. 6) on the Kellerville Quadrangle also began production in 1959. The discovery well was drilled in October 1959 by Charles Eager on the W. L. Davis farm, in the SE, SW, SE, Sec. 8, T2S, R4W, Brown County. Initial production was about 120 barrels of oil per day from porous Silurian dolomite at a depth of 634 feet. Upon completion, the well initially averaged 530 barrels per day. Initial production from offset (nearby) wells in the Siloam ranged from 70 to 300 barrels of oil per day (Howard 1961). The Siloam was extended to the east in May 1960 in the NE, NW, SW, Sec. 9, T2S, R4W, when the No. 2-P well was drilled by T. W. Pannell on the Kenneth Lee property. Initially, this well produced 500,000 cubic feet of gas and 100 barrels of oil per day. After completion, it produced 70 barrels of oil and 20 barrels of water per day from the Silurian at the 671 to 676 foot interval.

Eight wells in the Siloam Oil Field accounted for most of the cumulative 96,000 barrels of oil produced by the end of 1960, and the annual production of 27,600 barrels (Howard 1961). As of 1988, oil production from the entire field had fallen to 6,100 barrels per year (Huff 1988). There were 35 producing wells in the field by 1988 (Huff 1988). To date, cumulative production has totaled some 312,500 barrels for the Kellerville field and 301,500 barrels for the Siloam field.

The pay zone for oil production in both the Kellerville and Siloam fields occurs in the Kankakee Formation (Silurian)(fig. 2). The combined thickness of the Kankakee and Edgewood Formations averages only 11 to 15 feet in the area; but in the Siloam field, the combined thickness increases to 25 to 28 feet. A maximum thickness of 53 feet was reported in the SE, NE, SE, Sec. 8, T2S, R4W. The overlying Devonian carbonates are absent over most of the oil fields, and the Kinderhook–New Albany Shale rests directly on the Silurian Kankakee Formation (Howard 1961). A few miles to the west, the Silurian carbonates have been removed by erosion, and the New Albany Shale rests directly on the Maquoketa Shale.

The Kankakee pay zone is a vuggy, in places cavernous, slightly fossiliferous dolomite that occurs in the lower half of the formation. The pay zone typically lies about 1 or 2 feet above the underlying Maquoketa Shale. Thicknesses of the pay zone are erratic, with maximum thicknesses of around 7.5 feet (Howard 1961). Although located on a structural shelf or terrace, effective porosity seems to be the dominant factor in controlling oil and gas productivity (Howard 1961). Some of the structurally highest areas in the Kellerville and Siloam fields had dry holes, which indicates a lack of porosity. Oil and gas occur in the structurally higher parts of porous lenses at the base of the Kankakee Formation (Howard 1961).

## Limestone Resources

Middle Mississippian rocks in western Illinois that are potential sources of construction aggregate include the Burlington–Keokuk, Warsaw, Salem, and St. Louis Formations (Harvey 1964, Goodwin and Harvey 1980, Cloos and Baxter 1981).

The Burlington and Keokuk Limestones are major sources of construction aggregate and high-calcium limestone in western Illinois (Goodwin and Harvey 1980, Closs and Baxter 1981). Several quarries and some underground mines operate in the Burlington–Keokuk in several counties in western Illinois (e.g., Adams, Calhoun, Hancock, Pike, Henderson, etc.).

In the area of the Kellerville and Fishhook Quadrangles, the Burlington–Keokuk typically occurs 75 to 250 feet below the Quaternary sediments and, in most areas where mapped, is buried too deeply to be accessible for mining at the present time. The few exceptions include locations on the Fishhook Quadrangle where the upper 10 to 30 feet of the Burlington–Keokuk crops out along McKee Creek in the eastern part of Sec. 32, T2S, R4W, Brown County, and the northeast corner of Sec. 5, T3S, R4W, Pike County, as well as an unnamed creek in the central and western part of Sec. 4, T4S, R5W, Adams County. Where overburden is thin, the combined Burlington–Keokuk, upper Warsaw–Salem, and St. Louis roughly provide 300 feet of carbonate rock for potential major quarrying operations.

The Warsaw Formation, which overlies the Keokuk Limestone, is widely present in the field trip area. The Warsaw is divisible into two units (Lasemi et al. 1999): (1) a lower, shale-dominated interval (the lower Warsaw) and (2) an upper, carbonate-dominated interval (the upper Warsaw). In west-central and northwestern Illinois and southeastern Iowa, the upper Warsaw may contain good-quality, dense, biohermal dolomite, which is an excellent source of construction aggregate (Lasemi et al. 1999).

The lower half of the Warsaw in the Kellerville and Fishhook Quadrangles is characterized by geode-bearing, greenish gray siltstone, silty mudstone, and silty shales interbedded with thin argillaceous limestone (grainstone to packstone). During mapping of the Kellerville and Fishhook Quadrangle, we also found a significant thickness of limestone in the upper part of the Warsaw Formation. These carbonate rocks are best exposed along McKee Creek, Fishhook Creek, Lanes Branch, and Grindstone Creek. Along these streams, the upper Warsaw contains 10 to 30 feet or more of dolomitic, slightly sandy, fossiliferous limestone that is greenish gray but typically weathers grayish orange to grayish yellow-orange in color. In some areas, such as along McKee Creek, the upper Warsaw carbonate forms large cliffs or bluffs over 30 feet thick, consisting of one or two massive carbonate ledges interbedded with greenish gray shale. In other areas, these ledges grade into a thinner, argillaceous, fossiliferous limestone (grainstones to packstones) similar to those seen in the lower part of the formation. Locally, the upper Warsaw carbonate rock is eroded, and the Pennsylvanian rests unconformably on the lower shaley part of the Warsaw.

In places, the Warsaw carbonates (limestone and dolomitic limestone) are of sufficient quality for most construction purposes. However, because of their limited thickness and distribution in the field trip area, these carbonates are unlikely to be a major source of construction aggregate except for local use in moderate- or small-size quarrying operations. Where the upper Warsaw carbonates occur at or near the surface, they are weathered and relatively soft for most construction purposes. However, in areas where the overlying Salem–St. Louis limestones are relatively thick in western Illinois, the upper Warsaw carbonates are less weathered and the quality improves significantly.

Other potential aggregate resources in the area include the limestone and dolomite in the Salem and St. Louis Formations. The Salem is generally thin or absent in the field trip area, and the St. Louis occurs only in scattered locations due to pre-Pennsylvanian erosion.

The St. Louis may represent only a marginal source of aggregate for local use in the part of the field trip area where it is thickest. The St. Louis is best exposed along the southern reaches of Little Missouri Creek (east half of Sec. 17, T2S, R4W, Brown County), where it is up to 20 feet thick, and Walnut Fork Creek (east half of Sec. 5, T2S, R5W, Adams County), where it is 20 to 30 feet thick. Elsewhere in the field trip area, the St. Louis is thinner and very discontinuous due to erosion at the Mississippian–Pennsylvanian unconformity.

Aggregate resources are being lost to urbanization in rapidly developing regions such as the St. Louis Metro East or Quincy areas. The Burlington–Keokuk, Warsaw, Salem and/or St. Louis Limestones can provide significant amounts of much-needed construction aggregate for maintaining local and state infrastructure in western Illinois. The sparsely populated areas of the state such as west-central Illinois will be exploration targets for these valuable resources needed to maintain infrastructure in the rapidly developing regions. A proactive mapping strategy in such areas is essential to document availability of resources for future use.

## Mineral Production

The total value of all minerals extracted, processed, and manufactured in Illinois during 1995 was $2,202,300,000. Minerals extracted accounted for 87.6% of this total. Coal continued to be the leading commodity, followed by industrial and construction materials, oil, metals, peat, and gemstones. Illinois ranked 5th among coal-producing states, 13th among the 31 oil-producing states, and 16th among the 50 states in total production of nonfuel minerals, but continues to lead all other states in production of industrial sand and tripoli.

Adams County ranked 29th among all Illinois counties in 1992 on the basis of the value of all minerals extracted, processed, and manufactured. Economic minerals currently mined in Adams County include stone (limestone), sand and gravel, crude oil, and natural gas. Although no coal mines are currently active in Adams County, cumulative production equals 341,924 tons. The cumulative oil production equals 289,000 barrels.

Brown County ranked 86th among all Illinois counties in 1992 on the basis of the value of all minerals extracted, processed, and manufactured. Crude oil is the only economic mineral currently being extracted. Although no coal mines are currently active in Brown County, cumulative production equals 74,068 tons. The cumulative oil production equals 2,156,000 barrels. It is of historical interest to note that Pennsylvanian and Pleistocene clays in the Brown County area were used by both Indians and early settlers to make pottery. One of the earliest known potteries in the state was founded at Ripley in 1836, where stoneware was produced from clay occurring below the

Colchester Coal. Clay was also supposedly mined within Siloam Springs State Park for use in making containers (jugs ?) that were used to store and transport the valuable mineral waters collected from the springs. Pennsylvanian (at Stop 1) and Pleistocene (at Stop 2) clays are present in the park.

## Groundwater

Groundwater is a mineral resource frequently overlooked in assessments of an area's natural resource potential. The availability of this mineral resource is essential for orderly economic and community development. More than 35% of the state's 11.5 million citizens and 97% of those who live in rural areas depend on groundwater for their water supply. Groundwater is derived from underground formations called aquifers. The water-yielding capacity of an aquifer can only be evaluated by constructing wells into it. After construction, the wells are pumped to determine the quality and quantity of groundwater available for use. The Keokuk–Burlington limestone is the main source of private water supplies within the field trip area.

# SILOAM SPRINGS STATE PARK

Nature's bounty has conspired to produce at Siloam Springs State Park a natural beauty and source of recreation greatly prized by generations of Midwesterners (fig. 15). The beautifully wooded terrain, sparkling lake, and carefully maintained facilities make this 3,323-acre site one of the most beautiful parks in Illinois. It's an ideal setting for outdoor visits, whether your interest is hunting, fishing, camping, boating, picnicking, hiking, or bird watching. The park is surrounded by luxuriantly forested gullies and scenic crests alive with wild roses, black-eyed Susans, white false indigo, and snapdragons.

## History

Originally part of the "military tract" of western Illinois (land set aside as payment to volunteer soldiers in the War of 1812), the area was acquired in 1852 by George Meyers for his service in the Black Hawk and Mexican wars. He died in 1882 at the age of 102. Legend has it that spring water in the area had a medicinal effect, thus the name Siloam Springs from a Biblical reference (Siloam is a pool of water near Jerusalem), so-named by the Rev. Reuben K. McCoy, who had discovered the springs following the Civil War.

After Meyers' death, Quincy Burgesser, a local businessman and stock dealer, became aware of the springs and their curative value. He had the water analyzed and discovered it had more "strength" (a higher mineral content) than water from the famous Eureka and Waukesha springs.

Burgesser touted the water's ability to cure almost all ailments, even drunkenness and drug addiction. By 1884 he had erected two spring houses, a bathing house and the Siloam Forest Home Hotel, and the area became a popular and fashionable resort. Water from the No. 2 spring was bottled and distributed as far west as Kansas City, and bottling became a flourishing business for several decades.

In 1935, the Siloam Springs Recreation Club purchased the site in an effort to restore it and provide a place of recreation for the local population. Citizens of Adams and Brown Counties raised money to match state funds, and by 1940 an agreement was reached to make it a state recreation area. Eventually, the old hotel and bath houses were torn down, the swimming pool was abandoned, and the springs were no longer used. The No. 2 spring house was rebuilt in 1995 and contains the most popular spring.

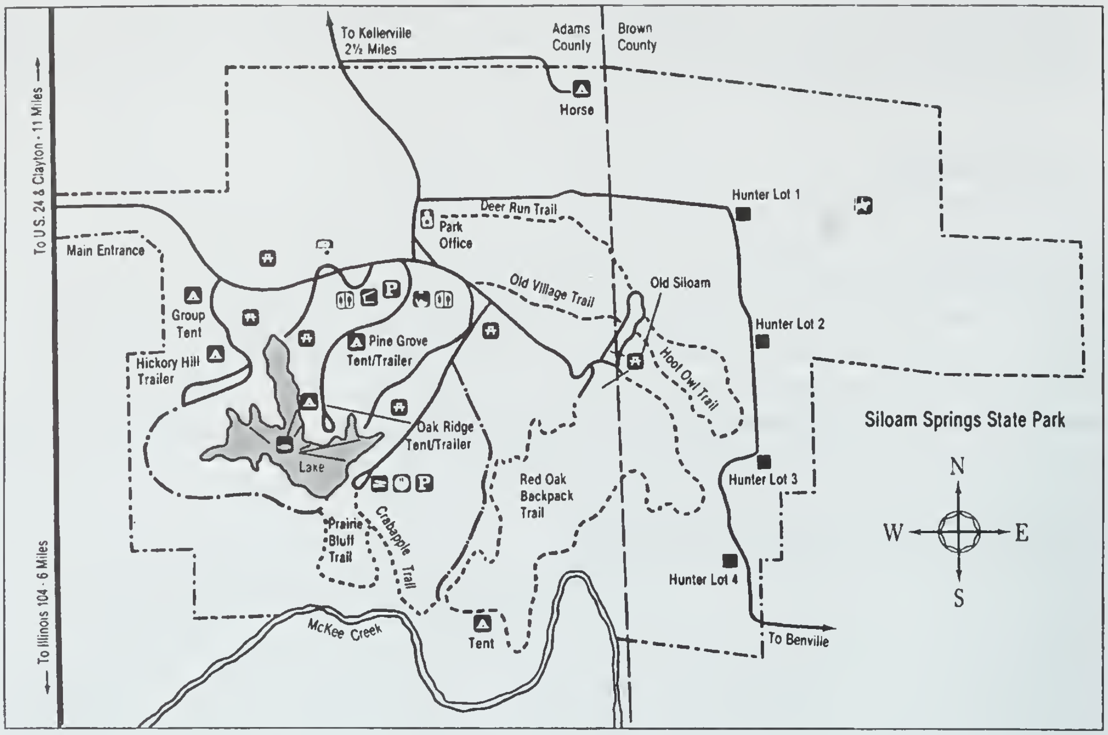



**Figure 15** Road and trail map of Siloam Springs State Park.

In 1954 and 1955, an earthen dam was constructed across a deep ravine, and the 58-acre Crabapple Lake was created. In 1956 Siloam Springs was dedicated as a state park, and efforts began to develop its recreational facilities.

## Recreation

**Picnicking** Old Siloam picnic area provides visitors with four shelters, charcoal grills, rest rooms, shaded tables, and playground equipment. The main shelter house, which holds more than 20 tables, also provides flush toilets, hot and cold water, grills, playground equipment, plenty of parking, and a set of horseshoe pits. In addition, there are several other smaller areas scattered along the park entrance road that provide tables and grills.

**Camping** If you want to spend a night or two under the stars, there are 98 Class A camp sites featuring rest rooms, showers, and electricity, 84 Class B camp sites featuring showers and rest rooms, and four backpack camp sites, in addition to a special group campground. There is a centrally located shower facility available to all campers.

**Fishing** The lake is stocked with largemouth bass, bluegill, redear and green sunfish, carp, crappie, channel catfish, and rainbow trout.

**Hiking** Hiking the Siloam Springs trails brings you closer to the many wildflowers found throughout the park, including wild roses, snapdragons, and black-eyed Susans. There are about 12 miles of scenic hiking trails that go from valleys to flatlands throughout the park, including a combination 6-mile hiking and backpacking trail. Most trails are easy, but Hoot Owl at 1.5 miles and Red Oak backpack trail at 4 miles are moderate. Four primitive camp sites are also available for those who wish to hike to them.

**Horse Trails and Equestrian Camping** The park contains equestrian trails totaling 23 miles, covering ridgetops and steep wooded valleys. There is a separate camping area for riders and their mounts, with water and limited electricity. Horse rentals are not available.

For more information, contact Siloam Springs State Park, Park Office, R.R. 1, Box 204, Clayton, IL 62324, 217-894-6205.

# Guide to the Route

We'll start the trip in the parking lot for the main shelter house at Siloam Springs State Park. The shelter is located 1 mile from the main entrance of the park on the right side of the road (NE, SE, SE, Sec. 14, T2S, R5W, 4th P.M., Kellerville 7.5-Minute Quadrangle, Adams County). Milage will start at the west exit of the parking lot.

*You must travel in the caravan.* Please drive with headlights on while in the caravan. Drive safely but stay as close as you can to the car in front of you. Please obey all traffic signs. If the road crossing is protected by an Illinois State Geological Survey (ISGS) vehicle with flashing lights and flags, please obey the signals of the ISGS staff directing traffic. When we stop, park as close as possible to the car in front of you and turn off your lights.

*Private property* Some stops on the field trip are on private property. The owners have graciously given us permission to visit on the day of the field trip only. Please conduct yourselves as guests and obey all instructions from the trip leaders. So that we may be welcome to return on future field trips, follow these simple rules of courtesy:

- Do not litter the area.
- Do not climb on fences.
- Leave all gates as you found them.
- Treat *public* property as if you were the owner—which you are!
- Stay off of all mining equipment.
- Parents must closely supervise their children at all times.

When using this booklet for another field trip with your students, a youth group, or family, remember that *you must get permission from property owners or their agents before entering private property.* No trespassing please.

Four USGS 7.5-Minute Quadrangle maps (Fishhook, Kellerville, Mt. Sterling, and Perry West) provide coverage for this field trip area.

| Miles to next point | Miles from start | |
|---|---|---|
| 0.0 | 0.0 | Set your odometers to 0.0 at the west end of the parking lot. Exit parking lot and TURN RIGHT onto the main park road. There are a large number of bicyclers and hikers in the park. Please use caution when driving through the park. |
| 0.2 | 0.2 | T-intersection from the right. Entrance road to Pine and Oak Ridge Camp Grounds. CONTINUE AHEAD. |
| 0.05 | 0.25 | T-intersection from the left. CONTINUE AHEAD. The park office is to the left. |

| | | |
|---|---|---|
| 0.25 | 0.5 | Y-intersection. BEAR RIGHT. Follow signs toward the boat launch and concession stand. |
| 0.05 | 0.55 | T-intersection from the right. CONTINUE AHEAD. |
| 0.3 | 0.8 | Y-intersection. BEAR LEFT. Follow main road toward boat launch and concession stand. Note: The car-top boat ramp is to your right. |
| 0.6 | 1.4 | Enter parking lot for the concession stand and boat ramp. Park car and walk toward the auxiliary spillway area. |

---

**STOP 1 Crabapple Lake – Auxiliary Spillway** (NW, NW, SW, Sec. 24, T2S, R5W, 4th P.M., Kellerville 7.5-Minute Quadrangle, Adams County). The auxiliary spillway is located on the northeast end of the earthen dam. We will examine the Pennsylvanian Colchester Coal and overlying Quaternary and underlying Mississippian unconformities.

---

| | | |
|---|---|---|
| 0.0 | 1.4 | Leave Stop 1. Retrace your route back to the main park road. |
| 0.7 | 2.1 | Angled-intersection from the left. CONTINUE AHEAD. |
| 0.2 | 2.3 | Y-intersection. BEAR RIGHT. |
| 0.05 | 2.35 | T-intersection with main park road. TURN RIGHT; heading toward Siloam Springs Picnic Area. |
| 0.05 | 2.4 | Notice the deeply eroded valley to your left. |
| 0.2 | 2.6 | CAUTION: steep hill, slow down. Descending into valley cut by Siloam Springs Creek. |
| 0.2 | 2.8 | T-intersection from the right leading to Shelter No. 3. CONTINUE AHEAD. Follow one-way road through the Springs Picnic Area. |
| 0.1 | 2.9 | Cross bridge over Siloam Springs. CAUTION: weight limit, 2 tons. Entering Brown County when you cross the bridge. |
| 0.2 | 3.1 | Shelter No. 2, on your right, is the site of the original 1884 Mineral Spring. This shelter is a reproduction of the original shelter house that was built over the spring. Park along the right-hand side of the road and pull over as far as you can. |

**STOP 2 Siloam Springs Picnic Area**

**A. Mineral Springs** (SW, SW, Sec.18, T2S, R4W, 4th P. M., Kellerville 7.5-Minute Quadrangle, Brown County). We will examine and discuss the geology surrounding the mineral springs. Note: The Kellerville topographic map indicates two springs in the area (see route maps). The springs are located directly opposite each other, one on either side of Siloam Creek.

**B. Exposure of Glacial Deposits** (NE corner of the NE, SE, SE, Sec.13, T2S, R5W, 4th P.M., Kellerville 7.5-Minute Quadrangle, Adams County).

---

| | | |
|---|---|---|
| 0.0 | 3.1 | Leave Stop 2. Follow the loop road back toward the main park road. |
| 0.1 | 3.3 | The second spring is located within the concrete structure on the right side of the road. |
| 0.05 | 3.35 | Old Village Trail to the right. |
| 0.15 | 3.5 | T-intersection from the left. Shelter No. 3. CONTINUE AHEAD. Road ascends valley cut by Siloam Creek. |
| 0.05 | 4.0 | Y-intersection. BEAR RIGHT. |
| 0.1 | 4.1 | T-intersection from the left. CONTINUE AHEAD. |
| 0.2 | 4.3 | Y-intersection. BEAR RIGHT. Follow sign to park office. |
| 0.1 | 4.4 | Park office on your right. CONTINUE AHEAD. |
| 0.15 | 4.55 | T-intersection from your right (3003E and 0950N). CONTINUE AHEAD on 0950N. Follow the sign to Kellerville and horse camping area. Note: Road to your right leads to Wildwood Girl Scout Camp and Benville. |
| 0.55 | 5.1 | T-intersection from the right (1000N and 3003E). CONTINUE AHEAD. Road to the right leads to the horse camping area. Tall, cylindrical, blue water tower is on the left. Note: Intersection signs are oriented in the wrong direction. We are traveling on 3003E, heading north. |
| 0.55 | 5.65 | Road curves 90° to the left. |
| 0.15 | 5.8 | T-intersection to the right (1050N and 2975E). TURN RIGHT. |
| 0.5 | 6.3 | T-intersection from the right (1100N and 2975E). CONTINUE AHEAD. Durbin and Lierly Cemeteries are on the left side of the road. The abandoned Kellerville Oil Field is located to your right. Most of the wells are located on the south side of Durbin Branch (see route map). The Kellerville field was discovered in 1959 and abandoned in 1964. Production was from the Silurian dolomite at a depth of 600 to 675 feet. |

| | | |
|---|---|---|
| 0.5 | 6.8 | Oil tank battery on the right; an abandoned oil well is east of the oil tanks. |
| 0.4 | 7.2 | STOP: 1-way; T-intersection (1200N and 2975E). TURN RIGHT. You are heading east toward Kellerville. |
| 0.35 | 7.55 | STOP: 4-way intersection (3000E and 1200N). CONTINUE AHEAD. The stop sign is located in the center of Kellerville, in McKee Township. It had an active post office from 1875 to 1931. This site was first known as Hickory Corner, then Payton, Peyton's, and finally Kellerville. |
| 1.05 | 8.6 | Entering Brown County. Road curves to the right. CONTINUE AHEAD. Note: The intersection (000E and 585N), located in the middle of the curve on your left, marks the county boundary. |
| 0.25 | 8.85 | Road descends into the valley cut by Purpus Creek. |
| 0.25 | 9.1 | Cross Purpus Creek. CONTINUE AHEAD. A large outcrop of the Pennsylvanian Purington Shale is located on the east side of the creek approximately 600 feet north of the bridge (SW, SW, NW, Sec. 6, T2S, R4W, 4th P.M., Kellerville 7.5-Minute Quadrangle, Brown County). |
| 0.6 | 9.7 | T-intersection from the left (080E and 550N). CONTINUE AHEAD. |
| 0.05 | 9.75 | Cross Wells Creek. CONTINUE AHEAD. The Pennsylvanian-age Mecca Quarry Shale is exposed in the bed of the creek north of the bridge. |
| 1.15 | 10.9 | Cross-road intersection (575N and 200E). CONTINUE AHEAD. For the next several miles, there is a series of oil tanks and oil wells to the right and left of the road. This is the Buckhorn Oil Field. While conducting field work in preparation for this field trip, we only encountered one working pump jack in this area. |
| 0.8 | 11.7 | Cross Cronin Hollow. |
| 0.95 | 12.65 | T-intersection from the right (360E and 600N). CONTINUE AHEAD. |
| 0.45 | 13.1 | T-intersection from the left (400E and 600N). CONTINUE AHEAD past the intersection and PULL OVER to the right side of the road. |

---

**STOP 3 Buckhorn Oil Field** (SW, SW, SW, Sec. 35, T1S, R4W, 4th P.M., Mt. Sterling 7.5-Minute Quadrangle, Brown County).

---

| | | |
|---|---|---|
| 0.0 | 13.1 | Leave Stop 3. CONTINUE AHEAD. |
| 0.35 | 13.45 | Road curves 90° to the right. CONTINUE AHEAD on main road. Intersection of two secondary roads to the left, at the beginning of the curve |

| | | |
|---|---|---|
| 0.55 | 14.0 | T-intersection from the left (550N and 450E). CONTINUE AHEAD. Road to the left leads to IL Route 107. |
| 1.4 | 15.4 | Road curves 90° to the right. |
| 0.45 | 15.85 | Road curves 90° to the left. CONTINUE AHEAD on main blacktop road, and follow the sign toward Wildwood. There is a secondary gravel road intersection (405E and 400N) at the beginning of the curve. |
| 0.25 | 16.1 | T-intersection from the left (370N and 400E). CONTINUE AHEAD. Note the till and loess exposure on the right-hand side of the road. |
| 0.3 | 16.4 | Road curves 90° to the right. |
| 0.2 | 16.6 | Road curves 90° to the left. |
| 0.2 | 16.8 | Road curves 90° to the right. |
| 0.2 | 17.0 | Road curves 90° to the left. |
| 0.2 | 17.2 | T-intersection from the right (310N and 350E). CONTINUE AHEAD. |
| 0.1 | 17.3 | T-intersection from the left (300N and 350E). CONTINUE AHEAD, heading south. |
| 0.1 | 17.4 | The small, white, clapboard-sided building on the right is the Buckhorn Township Hall. The village of Buckhorn, however, is in Lee Township, some 3½ miles north of here, about ½ mile north of Stop 3. |
| 0.4 | 17.8 | T-intersection from the right (250N and 350E). CONTINUE AHEAD. |
| 0.6 | 18.4 | T-intersection from the left (200N and 320E). CONTINUE AHEAD. Follow sign toward Wildwood. |
| 0.65 | 19.05 | Benville Church on the left side of the road. The cemetery behind the church, according to the *Guinness Book of World Records*, is the final resting place of the world's heaviest man, Robert Hughes, who weighed 1,041 pounds. His grave is located southwest of the church. One of the attractions at Hollywood's Guinness World of Records Museum is a life-size figure of Robert Hughes next to a step-on scale, so visitors can compare the combined weight of their entire family to Hughes' weight. |
| 0.05 | 19.1 | Just past the church, the main road curves 90° to the left. T-intersection (175N and 255E) to the right. TURN RIGHT onto 255E. Follow sign toward Wildwood. |
| 0.25 | 19.35 | T-intersection from the right (225E and 175N). CONTINUE AHEAD. Note: The road to the right leads to the Wildwood Girl Scout Center. This 1,650-acre Girl Scout Camp is operated by the Two Rivers Council. The camp is named Two Rivers Camp on the Mt. Sterling topographic map (see route map). |

| | | |
|---|---|---|
| 0.35 | 19.7 | To your left is a view of the of northwest–southeast-trending ridge on the opposite side of McKee Creek. |
| 0.45 | 20.15 | Road descends into the valley cut by McKee Creek and its tributary Little Missouri Creek. |
| 0.1 | 20.25 | Limestone of the Mississippian-age Warsaw Formation outcrops on the right side of the road. |
| 0.2 | 20.45 | PULL OVER to the right side of the road; park on the east side of the bridge. |

---

**STOP 4 Little Missouri and McKee Creeks** (NW, SW, SE, Sec. 20, T2S, R4W, 4th P.M., Fishhook 7.5-Minute Quadrangle, Brown County). Walk along the east bank of Little Missouri Creek to where it enters McKee Creek, and then follow McKee Creek downstream to an exposure of the Warsaw Formation on the outside of a large U-shaped meander (see route map). We will examine exposures of Warsaw Formation shales and limestones and discuss the geology of Little Missouri and McKee Creeks.

---

| | | |
|---|---|---|
| 0.0 | 20.45 | Leave Stop 4. CONTINUE AHEAD. Cross bridge over Little Missouri Creek. |
| 0.9 | 21.35 | Road curves 90° to the left. |
| 0.2 | 21.55 | Road curves 90° to the right and begins ascent out of the valley. |
| 0.1 | 21.65 | T-intersection from the left (200N and 075E). CONTINUE AHEAD. Follow sign toward Siloam Springs State Park. |
| 0.1 | 21.75 | Exposure of loess on the right side of the road. |
| 0.2 | 21.95 | Road curves to the right, entering Siloam Springs State Park. |
| 0.45 | 22.40 | Sign on the right side of the road (345N and 000E). This sign is out-of-place; it should be located where the road crosses the Adams–Brown county line 1.65 miles to the north. |
| 0.15 | 22.55 | The fire lane on the left side of the road is marked pedestrians only. This is part of the Red Oak Backpack Trail. This trail leads to Siloam Springs Creek, and you can follow it to McKee Creek within the state park. A small pull-over is just past the fire lane on the left side of the road. |
| 0.1 | 22.65 | The trail on the left, Hoot Owl Trail, will lead you to Siloam Springs Picnic Area. |
| 0.1 | 22.75 | Hunter lot 3 on the right side of the road. Note the large number of pine trees in this area. These were planted on old non-fertile farmland when the State of Illinois acquired the property. |

| | | |
|---|---|---|
| 0.3 | 23.05 | Hunter lot 2 on the right side of the road. |
| 0.2 | 23.25 | Siloam Springs Prairie Management area on the right. This area was established to maintain an example of the native prairie vegetation of western Illinois. |
| 0.3 | 23.55 | Hunter lot 1; another portion of the Siloam Springs Prairie Management area. |

Sign at Hunter lot 1:

> *The Illinois Department of Natural Resources and the U. S. Fish and Wildlife Service finance a wildlife habitat development project on this site.*
>
> *The Pittman-Robertson Act of 1937 earmarks specific funds for wildlife management. Revenue is derived from hunting license sales tax paid on ammunition and other sporting equipment. Sportsman dollars provide food strips, tree and shrub plantings, nest grass plantings, and many other wildlife management activities. Program objectives are to develop optimal habitat for wildlife inhabiting these sites and provide hunting opportunity.*

| | | |
|---|---|---|
| 0.5 | 24.05 | Enter Adams County. Note: This is where the sign at milage 22.4 should be placed. |
| 0.65 | 24.7 | STOP: 1-way. T-intersection of 3003E and 950N. TURN LEFT. |
| 0.25 | 24.95 | T-intersection. TURN RIGHT onto main park road. |
| 0.05 | 25.0 | T-intersection from the left. Entrance to Pine and Oak Ridge Camp Grounds. CONTINUE AHEAD. |
| 0.15 | 25.15 | TURN LEFT into parking lot of Main Shelter House. |

---

**STOP 5: LUNCH  Siloam Springs State Park – Main Shelter House**  Discussion of geologic mapping.

---

| | | |
|---|---|---|
| 0.0 | 25.15 | Exit parking lot and TURN LEFT. |
| 0.15 | 25.3 | Cattail Cove picnic area to the left. CONTINUE AHEAD. |
| 0.25 | 25.55 | Hidden Hollow picnic area to the right. CONTINUE AHEAD. |
| 0.15 | 25.7 | Hickory Hill Camp Ground to the left. CONTINUE AHEAD. |
| 0.65 | 26.35 | STOP: 1-way. T-intersection (2873E). Exit from the park. TURN LEFT. |

| | | |
|---|---|---|
| 0.4 | 26.75 | Road gently curves 90° to the right. CONTINUE AHEAD on main road. Intersection (2873E and 900N) from the left at the beginning of the curve. |
| 0.4 | 27.15 | Road gently curves 90° to the left. CONTINUE AHEAD. Illinois and Wisconsin Episode deposits are exposed on the left side of the road, in the small drainage way, and in the road bank. This stop was one of those used for the 1971 Mt. Sterling Area Geological Science Field Trip. A detailed description of the stratigraphy is included in the appendix at the back of this guidebook (see Siloam Springs West Section). |
| 0.3 | 27.45 | T-intersection from the right (0875N and 2873E). CONTINUE AHEAD. |
| 0.2 | 27.65 | Road begins descent into the valley cut by McKee Creek. |
| 0.7 | 28.35 | Cross McKee Creek. Note the old bridge abutment on the right. |
| 0.2 | 28.55 | T-intersection from the right (0800N and 2873E). TURN RIGHT and begin ascent out of the valley cut by McKee Creek. |
| 0.3 | 28.85 | Good view of the McKee Creek valley to the right. You are traveling along the top of the southern bluffs of McKee Creek valley. |
| 0.3 | 29.15 | Y-intersection (2873E and 800N). TURN LEFT onto gravel road. CAUTION: Blind intersection. Fast-moving oncoming traffic. View is obscured by a rise in the road. Note: The one-room building to the right, after you make the turn, is the old Highland school building. See sign above the doorway. The old country schools are indicated on the 1929 edition of the Mt. Sterling 15-Minute Quadrangle map, but not on the newer Fishhook 7.5-Minute Quadrangle map. |
| 0.35 | 29.5 | Road curves 90° to the left |
| 0.25 | 29.75 | Road curves 90° to the right. |
| 0.4 | 30.15 | Road curves 90° to the left. |
| 0.3 | 30.45 | T-intersection from your right (2753E and 0690N). Road gently curves to the left. Follow main road. |
| 0.5 | 30.95 | Cross Lanes Branch. Limestones of the Mississippian-age Warsaw Formation are exposed along the creek to the left. |
| 0.4 | 31.35 | Exposure of pre-Illinois episode glacial till on the left. This till is rusty brown and light gray mottled; it weathers to a distinct gray-brown horizon and contains abundant, small, black, iron-manganese nodules and streaks; it is clayey, fairly tight, and compact. |
| 0.2 | 31.55 | Large granitic erratic in the yard on the right side of the road next to the blue farm house. This is the largest erratic that we have seen in this area. |

| | | |
|---|---|---|
| 0.4 | 31.95 | CAUTION: Dangerous T-intersection (2753E and 550N). TURN LEFT. Oncoming drivers' view from the right is obscured by the hill. Main road curves 90E to the right. |
| 0.55 | 32.5 | Cross rocky ford on the left fork of Lanes Branch and PULL OVER to the right side of the road as far as you can. |

---

**STOP 6 Lanes Branch – Left Fork** (NW, NW, SW, Sec. 3, T3S, R5W, 4th P.M., Fishhook 7.5-Minute Quadrangle, Adams County). We will examine the Warsaw Formation and collect geodes.

---

| | | |
|---|---|---|
| 0.0 | 32.5 | Leave Stop 6 and CONTINUE AHEAD. |
| 0.1 | 32.6 | Exposure of Colchester Coal and underlying shale on the left side of the road as you ascend the hill. |
| 0.55 | 33.15 | STOP: 1-way. T-intersection (2873E and 550N). TURN LEFT. |
| 0.5 | 33.65 | T-intersection from the left (600N and 2873E). CONTINUE AHEAD. Just past the intersection on the left is a sign that reads: *Chestline, Illinois, population 2, established March 4, 1882, disestablished February 2, 1906*. Chestline is located on a township line. Beverly Township is to the south, and McKee Township is to the north. |
| 0.1 | 33.75 | Road begins descent into the valley cut by Fishhook Creek. |
| 0.5 | 34.25 | Cross Fishhook Creek. Note the exposure of the Warsaw Formation limestones and shales to the left along the creek. The resistant limestones of the Warsaw Formation form the western bluffs of the valley being eroded by Fishhook Creek. |
| 0.4 | 34.65 | T-intersection from the right (0700N and 2873E). TURN RIGHT, just before the bridge. |
| 0.2 | 34.85 | Cross east branch of Fishhook Creek. |
| 0.5 | 35.35 | Road begins ascent out of the valley cut by Fishhook Creek. |
| 0.5 | 35.85 | T-intersection (3000E and 700N). TURN RIGHT. Fairview Cemetery is on the southwest corner of this intersection. |
| 0.4 | 36.25 | Exposure of Peoria Silt (loess) and Illinois and pre-Illinois glacial deposits. This exposure is considerably overgrown. This was one of the stops used for the 1971 Mt. Sterling Area Geological Science Field Trip. A detailed description of the stratigraphy is included in the appendix at the back of this guidebook (see Greenwood School South Section). |

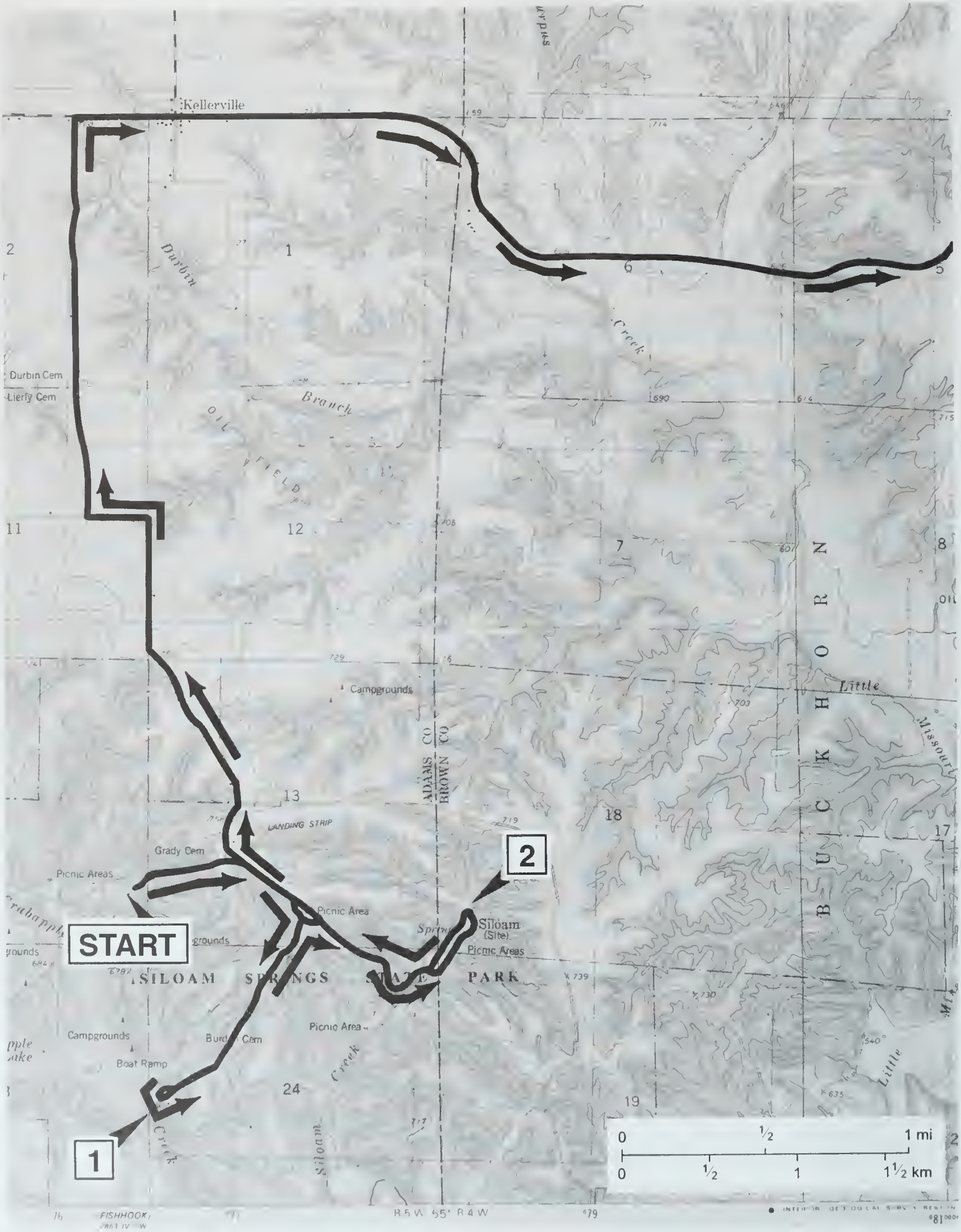
| | | |
|---|---|---|
| 0.1 | 36.35 | T-intersection from the left (650N and 3000E). CONTINUE AHEAD. |
| 0.4 | 36.75 | Road curves 90° to the right. |
| 0.3 | 37.05 | Road curves 90° to the left. Intersection (3000E and 600N) at the beginning of the curve is marked *No Outlet*. CONTINUE AHEAD on main road. |
| 0.5 | 37.55 | Approaching Fishhook Creek; pull over to the right side of the road. |

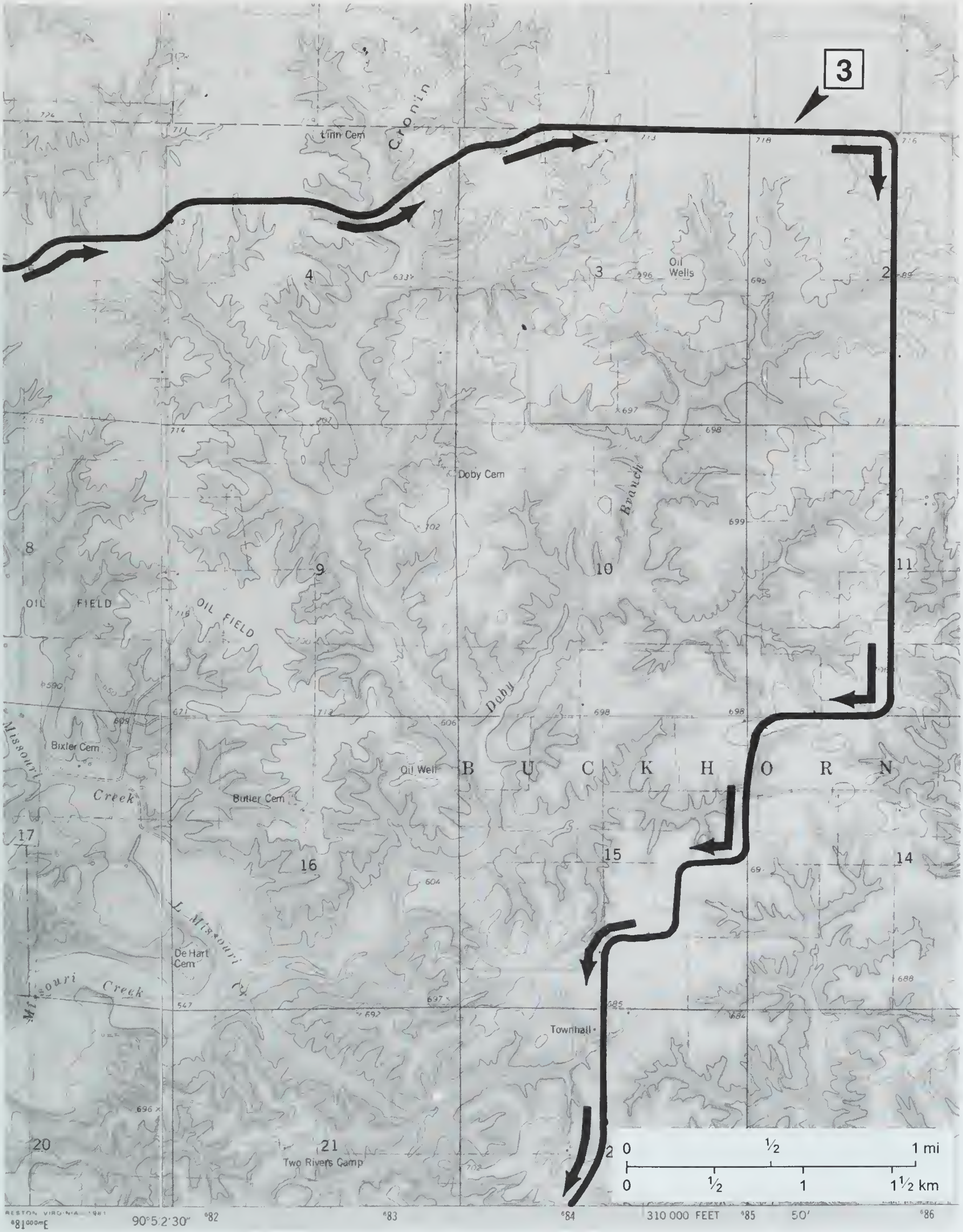
---

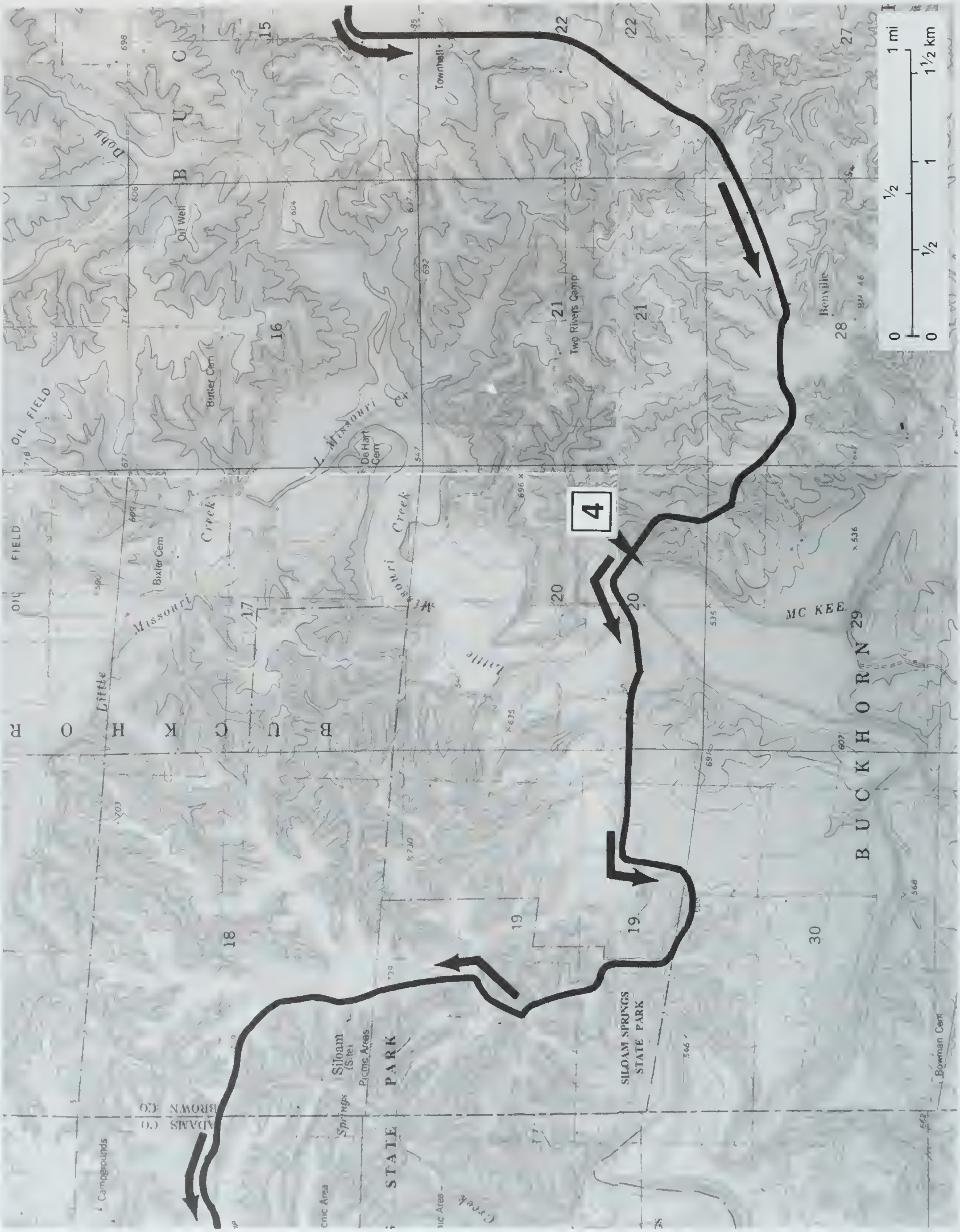
**STOP 7 Fishhook Creek** (NW, NE, SE, Sec. 2, T3S, R5W, 4th P.M., Fishhook 7.5-Minute Quadrangle, Adams County). Last stop on the field trip. We will examine the Warsaw Formation limestone and shale exposures in the creek. Opportunity to collect geodes and fossils.

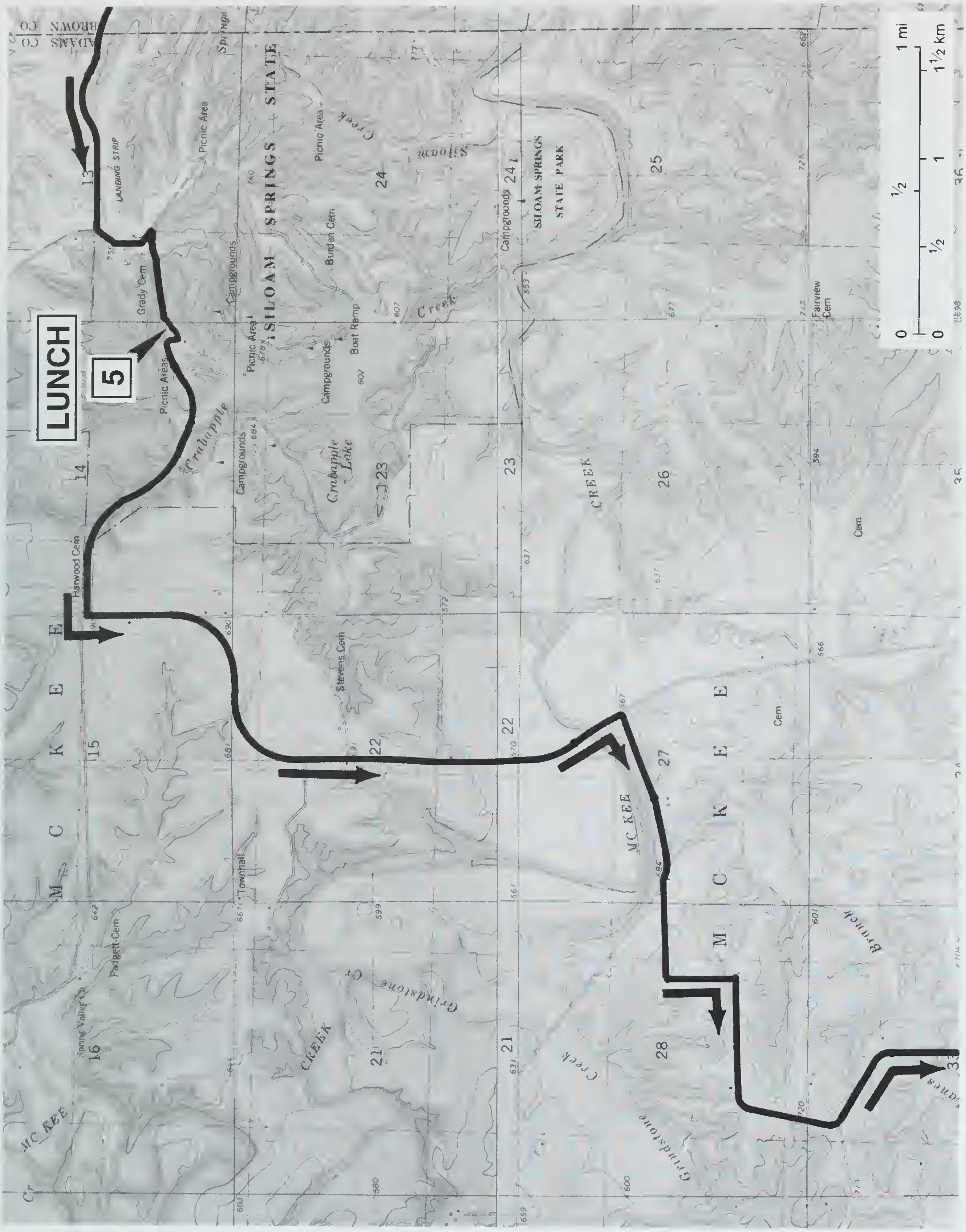
---

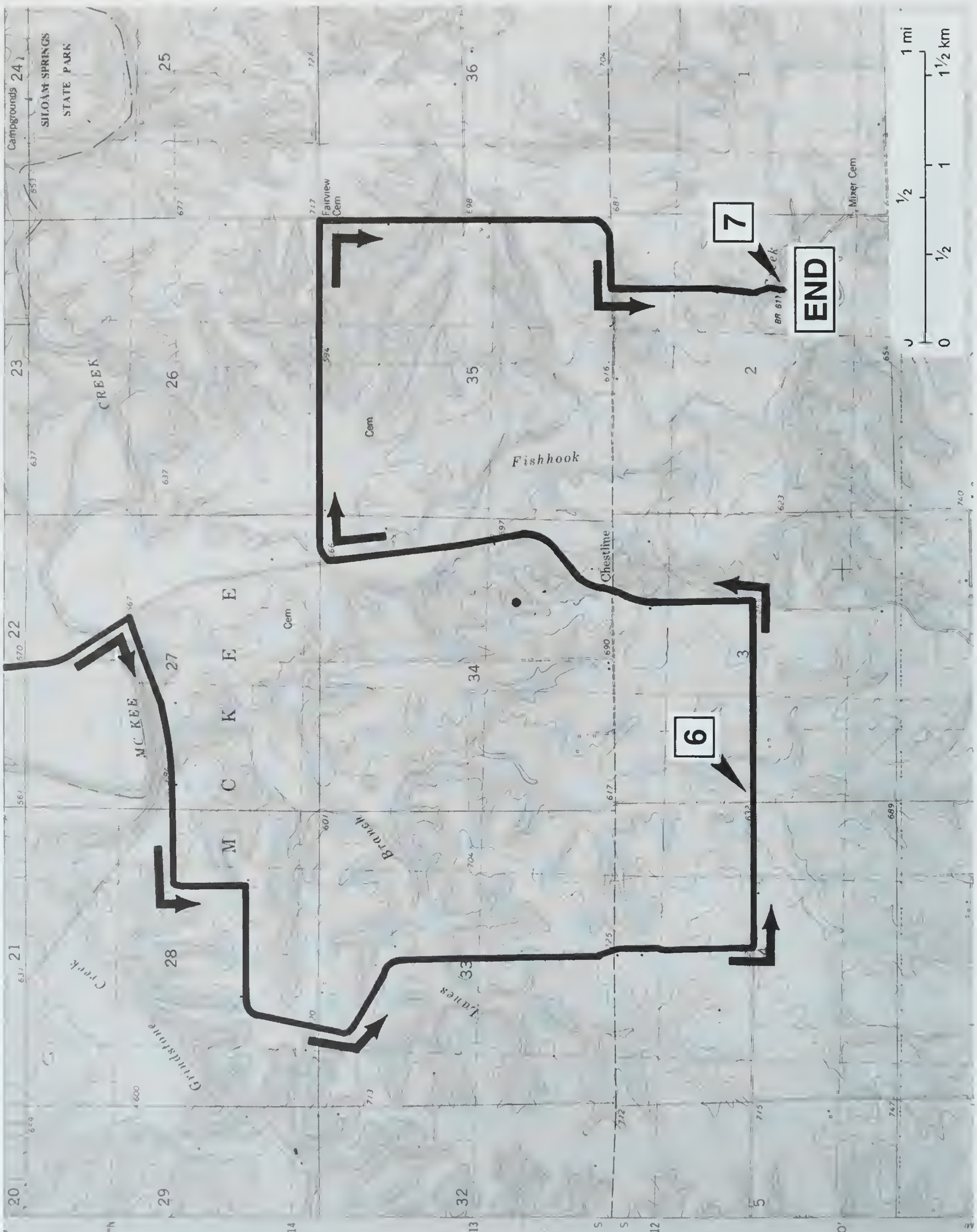
| | | |
|---|---|---|
| | | END OF TRIP Have a safe trip home! The following road log will guide you back home. |
| 0.0 | 37.55 | Leave Stop 7. Cross the bridge over Fishhook Creek. CONTINUE AHEAD. |
| 0.7 | 38.25 | STOP: 1-way. T-intersection (3000E and IL Rt. 104). TURN RIGHT to head toward Quincy, which is approximately 26 miles to the west. Or TURN LEFT to head toward Route 107, which is approximately 16 miles to the east. At Route 107, turn south and go 11 miles through Griggsville to I-72, or turn north and go 12 miles to U.S. 24 at Mt. Sterling. |


Kellerville
Durbin Cem
Lierly Cem
Durbin
Branch
OIL FIELD
Creek
Campgrounds
ADAMS CO
BROWN CO
LANDING STRIP
Grady Cem
Picnic Areas
Picnic Area
START
Siloam (Site)
Picnic Areas
SILOAM SPRINGS STATE PARK
Picnic Area
Campgrounds
Boat Ramp
Burdick Cem
Creek
Siloam Creek
BUCKHORN
Little Missouri
1
2
0 ½ 1 mi
0 ½ 1 1½ km


3
Linn Cem
Cronin
4
3
Oil Wells
2
Doby Cem
Branch
8
9
10
11
OIL FIELD
OIL FIELD
Doby
Missouri
Bixler Cem
Oil Well
B U C K H O R N
Creek
Butler Cem
17
16
15
14
L Missouri
De Hart Cem
Missouri Creek
Townhall
20
21
Two Rivers Camp
0 ½ 1 mi
0 ½ 1 1½ km
90°5 2'30"
310 000 FEET
50'


4
Townhall
Oil Well
Butler Cem
Bixler Cem
De Hart Cem
Two Rivers Camp
Benville
L. Missouri Cr.
Little Missouri Creek
OIL FIELD
BUCKHORN
MC KEE
SILOAM SPRINGS STATE PARK
Siloam (Site) Picnic Areas
Springs
STATE PARK
ADAMS CO
BROWN CO
Campgrounds
Bowman Cem
0 1/2 1 mi
0 1/2 1 1 1/2 km


LUNCH
5
ADAMS CO
BROWN CO
LANDING STRIP
Picnic Area
Grady Cem
Picnic Areas
Harwood Cem
Campgrounds
Picnic Area
Boat Ramp
Burden Cem
SILOAM SPRINGS STATE
SILOAM SPRINGS STATE PARK
Crabapple
Crabapple Lake
Siloam Creek
Stevens Cem
Townhall
Padgett Cem
Spring Valley Ch
Grindstone Cr
CREEK
MC KEE
Fairview Cem
Branch
1 mi
1½ km


Campgrounds
SILOAM SPRINGS
STATE PARK
CREEK
MC KEE
M C K E E
Cem
Branch
Grindstone
Creek
Fairview Cem
Fishhook
Chestline
Mixer Cem
6
7
END
BR 611
1 mi
1½ km

# Stop Descriptions

**STOP 1 Crabapple Lake – Auxiliary Spillway** (NW, NW, SW, Sec. 24, T2S, R 5W, 4th P.M., Kellerville 7.5-Minute Quadrangle, Adams County)(fig. 16)

Crabapple Lake covers 68 acres and has a watershed of 1,280 acres. The overflow spillway is located on the northeast end of the earthen dam. We will examine the Colchester Coal and the Mississippian–Pennsylvanian unconformity. The Pennsylvanian exposure is located in the auxiliary spillway just over the little ridge and to the left. The following description is modified from that in the *Mt. Sterling Area Geological Science Field Trip Guide Leaflet* (1971)

### Detailed Stratigraphy at Stop 1

**Quaternary System**

Pleistocene Series

Pre-Illinoian glacial episode – Probably till; no bedding apparent; rusty brown, weathered and oxidized; clayey, sandy, and very pebbly; 1' +

**Pennsylvanian System**

Carbondale Formation

Oak Grove Limestone Member

Shale – Gray brown; weathers with pronounced iron staining; fair bedding; partially slumped, with fossiliferous limestone fragments up to ½ inch thick scattered over surface; 3' 2"

Limestone – Brown, weathered, somewhat lenticular but persistent across exposure; fossiliferous (Chonetes, Mesolobus); 2"

Shale – Drab, fairly well bedded, soft, fossiliferous; sulfur masses and crystalline selenite in basal 3"; 1' 1"

Shale – Dark gray to black, well bedded, fissile; 9"; grades downward into:

Shale – Gray with considerable limonite on partings and bedding surfaces; fairly well bedded; contains large irregular masses of small selenite crystals; 2' 2"

Mecca Quarry Shale Member – Black, slatey, fissile; 2' 9"

Colchester (No. 2) Coal Member – Weathered, blocky; top 1" contains considerable fusain; 1' 4"

Underclay, dark gray; Stigmaria rootlets; 1'

Underclay, light gray; Stigmaria rootlets; 2' +

Tradewater Formation

Babylon (?) Sandstone Member – White with brown weathered crust, fine to medium grained, fairly firm; 1' + (base concealed)

**Mississippian System**

Warsaw Formation – Massive grainstone, cross-bedded; light gray, weathers yellowish brown to brownish tan; very fossiliferous with abundant bryozoans, brachiopod and echinoderm marine fossils; forms prominent ledges. Contact with overlying Pennsylvanian is obscured but is clearly unconformable; underlain by covered gray shales and thin limestones typical of the formation; 10' to 20'

*Note*: Colchester Coal is the preferred modern name for the No. 2 Coal. The unit is referenced both ways in many older publications.

Strata exposed here give an indication of the profound unconformity that exists between the Pleistocene and older rocks in Illinois. North of the park along Purpus Creek (mile 9.1 on road log) the Illinois Episode till rests upon Pennsylvanian Purington Shale; whereas here, the pre-Illinois drift overlies part of the Oak Grove Limestone. When just these two sites are compared, it is evident that at this site, at least 50 feet of strata, including the upper portion of the Oak Grove and the overlying Purington Shale were eroded away before Pleistocene deposits mantled the bedrock. Actually, much more rock probably was removed, as is evidenced by nearby exposures in which higher, younger Pennsylvanian strata can be seen. At some places in Illinois, bedrock older than Pennsylvanian immediately underlies the Pleistocene.

**Figure 16** Pennsylvanian-age Mecca Quarry Shale and Colchester Coal at the auxiliary spillway – Stop 1 (photo by W. T. Frankie).

Other features are distinctive of this site. The Francis Creek Shale, which generally occurs only in sags on top of the Colchester Coal, is missing, although it is present elsewhere in this vicinity. The Colchester Coal is thinner toward the southwest, closer to the Pittsfield and Fishhook Anticlines and the Mississippi River Arch. The clay section below the coal is thin and not too well developed. If the sandstone at the base of this section is Babylon, which it appears to be, then the intervening Seahorne Limestone and Cheltenham Clay have lensed out toward the higher parts of these structures.

Data for the Colchester Coal, the only coal recognized as having minable thickness in Adams County, are sparse and exit for widely separated localities. In the southeastern part of the county, the coal averages about 18 inches thick. Northward, however, it does thicken locally to as much as 36 inches. The coal has been strip-mined in the northeastern part of the county. Estimates of reserves indicate 88.3 million tons of Colchester Coal having overburden thicknesses between 0 and 50 feet may be available in the county. More than 328.5 million tons are calculated to occur with 50 to 100 feet of overburden, and more than 202.4 million tons have overburden thicknesses ranging from 100 to 150 feet.

Many of our Pennsylvanian coals are associated with incursions of marine-water transgressions that repeatedly invaded the low-lying deltaic coastline areas beside the shallow seas that covered much of the continent during the Pennsylvanian. The gradual deepening of the ocean water during these repetitive transgressions is marked first by coals formed near the subsiding shoreline, succeeded by marine black muds (which became shales) and lime muds (which became limestones). These transgressions and regressions are quite cyclic, especially in the Middle and Upper Pennsylvanian, and their characteristic rock successions are called cyclothems by geologists. For a detailed

discussion of the Pennsylvanian, the depositional environments represented by these rocks, and how and why cyclothems may have formed, see *Depositional History of the Pennsylvanian Rocks in Illinois*, at the back of the guidebook.

---

**STOP 2 Siloam Springs Picnic Area – Mineral Springs** (SW, SW, Sec.18, T2S, R4W, 4th P. M., Kellerville 7.5-Minute Quadrangle, Brown County).

---

We will examine and discuss the geology surrounding the springs at two sites.

**A. Mineral Springs** Note: The Kellerville topographic map indicates two springs in the area (see route maps). The springs are located directly opposite each other, one on either side of Siloam Creek.

**History of the Springs** The spring waters rising in this valley contain minerals that affect the water's taste; and in the last century, the supposed medicinal properties of the water inspired the construction of the Siloam Forest Home—a hotel with bath houses, swimming pool, and other facilities for "takers of waters." In other areas having spas and medicinal waters, it was frequently thought that the worse the water tasted, the greater its curative powers.

A village with about 75 inhabitants grew up around the resort. It had two general stores, a post office, a blacksmith's shop, and a grist mill. Although the springs were visited by the famous A. G. Ringling and P. T. Barnum and the great meat magnate Philip Armour, the spa failed, and in 1935 the hotel and its grounds were sold.

**Springs** Questions likely asked are why the springs are located here and how they formed. Surprisingly, the occurrence of springs is common in a large portion of Illinois. Springs are found along many of the valleys in the glacial drift that covers this and other regions of Illinois.

The water commonly flows out at the surface, usually from a layer of unconsolidated gravel or sand outcropping along the sides of a valley. Springs may also occur at the contact of a bed of gravel with an underlying relatively impervious bed, such as a layer of clay or shale. Springs that issue from the bedrock also occur in outcrops along larger streams. The water flows from between bedding planes in the rock, crevices, or just above a comparatively impervious layer.

**B. Exposure of Glacial Deposits** (NE corner of the NE, SE, SE, Sec.13, T2S, R5W, 4th P.M., Kellerville 7.5-Minute Quadrangle, Adams County).

Starting at the north end of the loop road, cross the small, wooden foot bridge and follow the creek bed in the northwest-trending valley. Stop 2B, a slump in the valley wall (fig. 17), is approximately 600 feet upstream, on the outside of one of the meanders.

As you follow the creek, notice the number of sharp, U-shaped meanders throughout the valley. The base of the creek is heavily loaded with sand, pebbles, and glacial erratics. Below the Quaternary alluvium in the creek is a clay deposit that was formed as an accretionary deposit in shallow, poorly drained depressions on the landscape surface. This clay is most likely the Lierle Clay Member, a pre-Illinoian accretion-gley of Yarmouthian age.

**Figure 17** Slump along Siloam Creek. Exposure of Illinois Episode glacial till and Wisconsin Episode Peoria Silt (loess) – Stop 2B (photo by W. T. Frankie).

**The Slump** This exposure is the result of a large slump that broke loose from the valley wall (fig. 17). In the middle of the slump block is a large sycamore tree. Illinois Episode till is exposed at the top of the slump scarp and is underlain by cross-bedded silts and fine-grained sands. The occurrence of the well-developed cross-bedding suggests the sediments were transported and deposited by flowing water. The middle cross-bedded unit is classified as stratified drift. Overlying this unit is the Peoria Silt, which was deposited during the Wisconsin Episode. The Peoria Silt is generally considered to have been deposited by wind.

A heterogenous mixture of clay, sand, gravel, and bolders deposited directly by ice is called till. Glacial drift that was sorted by water running from the glacier and then redeposited is called stratified drift.

### Simplified Stratigraphy at Siloam Springs Picnic Area

**Wisconsin Episode**

Peoria Silt – Loess, massive, leached, light tan brown; surface soil; 4' +

**Illinois Episode**

Till; heterogenous mixture of clay, silt, sand, gravel and boulders

Silt and very fine grained sand; cross-bedded; 10' +

**Pre-Illinois Episode**

Wolf Creek Formation

Lierle Clay Member – Gray and brown, with black organic fragments

**Figure 18** Oil field pump jack at Buckhorn Oil Field – Stop 3 (photo by W. T. Frankie).

---

**STOP 3 Buckhorn Oil Field** (SW, SW, SW, Sec. 35, T.1S, R.4W, 4th P.M., Mt. Sterling 7.5-Minute Quadrangle, Brown County). We will discuss oil production in the area (fig. 18).

---

## Oil and Gas Production in Western Illinois

Some of the earliest oil and gas discoveries in Illinois occurred in the west-central Illinois region surrounding the Siloam Springs field trip area. The earliest know production in the state was gas from wells drilled in shallow, glacial drift wells (also known as "marsh gas") in Champaign County in 1853 (W.S. Blatchley 1906). In 1865, wildcat drilling was undertaken in Clark County, Illinois (W.S. Blatchely 1906). The small town of Oilfield developed nearby after a small amount of oil was found, but the work was abandoned.

Gas was discovered in west-central Illinois in 1886 while drilling for water in Pike County, but the site was abandoned until 1905, when about 30 wells were drilled and Pittsfield Gas Field was discovered. Pittsfield Gas Field is located about 20 miles south of Siloam Springs State Park. The gas field is located along the crest of a pronounced anticlinal structure (an elongate upward-doming of the bedrock). The gas reservoir is in Silurian limestone and dolomite at depths of about 265 feet. Rapid depletion of the reservoir pressure resulted in abandonment of the field in the late 1880s.

### *Pittsfield Gas Field*

Pittsfield Gas Field has undergone several phases of discovery, abandonment, rediscovery, and abandonment. The field was re-drilled and new production was established in 1905; the field was then abandoned once again in 1930.

### *Fishhook Gas Field*

Continued exploratory drilling led to the discovery of Fishhook Gas Field, located about 7 miles south of the park, in 1955. Fishhook is located on the crest of the Fishhook anticlinal structure that trends sub-parallel to the Pittsfield Anticline. As at Pittsfield, the reservoir rock is dolomitic limestone of the Silurian System. Reservoirs are at depths of about 460 feet.

The Pittsfield–Fishhook anticlinal complex is an important bedrock structure that contributes to the entrapment of hydrocarbons in the region. Oil and gas fields in Adams, Brown, and Pike Counties are combination stratigraphic-structural traps that are associated with the anticlinal structure. Oil fields near the field trip site are located on subtle structural terraces that flank the Pittsfield–Fishhook anticlinal complex. The oil and gas reservoirs are in dolomite and dolomitic limestone of the Silurian System. The reservoir rocks are not exposed at the surface in the field trip area.

Interest in exploration for oil and gas resources in west-central Illinois has never waned. In 1959, wildcat drilling in the area established the Kellerville Oil Field.

### *Kellerville Oil Field*

Silurian oil reservoirs were first discovered in 1959 in western Illinois when Ray Starr completed the #1 Wendell Doole well in Section 11, T2S, R5W, Adams County, for 3 barrels of oil per day from the dolomite at the base of the Kankakee at a depth of 639 feet. Numerous offsets established that better production lay east of the discovery well, with some initial production rates exceeding 200 barrels of oil per day per well. From 1962 through 1964, development drilling extended Kellerville's production to Sections 1, 2, 11, and 12, 2S, 5W, as well as in Section 36,1S, 5W, Adams County. Twenty leases produced 179,369 barrels of oil by 1966, when production declined and the field was abandoned for the first time.

### *Siloam Oil Field*

Siloam, about 2½ miles southeast of Kellerville in neighboring Brown County, was drilled in 1959. The #1 W.L Davis well, in Section 8, T2S, R4W, initially produced 30 barrels an hour for 48 hours on pump from Silurian Kankakee dolomitic limestone at 634 feet subsurface. Development drilling in the next 4 years extended production to 15 leases in Sections 8, 9, and 16, T2S, R4W. In 1966, Siloam was abandoned for the first time, having produced a reported 208,500 barrels of oil.

In 1974, renewed drilling in Kellerville and Siloam, 8 years after abandonment, extended production again. Operator Claude McElvain drilled productive wells on the Allen and the Kirchherr leases in the Kellerville field in Section 2, T2S, R5W, and Section 35, T1S, R5W. By the beginning of 1982, Kellerville had produced an additional 25,365 barrels of crude oil from 12 additional leases. Siloam redrilling produced 24,372 barrels of oil from four leases by the beginning of 1982.

When Buckhorn East was discovered in 1982, drilling at Kellerville and Siloam was renewed again. An estimated 22 new producers extended the Kellerville field in 1983, increasing production approximately 50,000 barrels of oil in that year. At Siloam, an estimated nine new producing wells increased yearly production by almost 7,000 barrels during 1983. Buckhorn East has produced over 2 million barrels of oil. Kellerville and Siloam have each produced about 300,000 barrels of oil.

### ***Buckhorn Consolidated Oil Field***

**Buckhorn** The discovery well for the Buckhorn Oil Field, located about 4 miles northeast of the Kellerville discovery well, was drilled in July 1961. Buckhorn's #1 R. Davis, operated by J.P. Johnson, is in Section 33, T1S, R4W, Brown County. Initial production after acid was 48 barrels of oil per day from the Silurian Kankakee at 665 feet subsurface. Attempts to develop Buckhorn into a field met with little success, as only four productive wells were offset to the discovery well. In 1964, the Davis well was plugged back to 135 feet subsurface, leaving the well open for a water well.

Buckhorn was named a field by the Illinois State Geological Survey, but never acquired field status in the monthly Pipeline Production Report until the discovery of the Buckhorn East Oil Field some 20 years later. Production figures for the four original wells at Buckhorn are unknown. The two fields are now known as Buckhorn Consolidated.

**Buckhorn East** In 1980, Big Prairie Oil Company drilled the Franks #1 lease in the NW, SW, SW, Section 36, T1S, R4W. Production from the well went unreported, resulting in discovery-well status for Buckhorn East being awarded to another well, the R and R Enterprises Hippen #1 well, nearly 1 mile east in the NE, SE, SE, Section 36, T1S, R4W, drilled 2 years later. The Hippen #1 was reported completed in April 1982, with initial production of 125 barrels of oil reported from the basal Silurian "Edgewood Limestone."

Production in this reservoir is primarily from porosity that developed at the base of the Kankakee, but porous zones in the middle and upper Kankakee contribute to the pay. Wells with porosity at the base of the Kankakee have proven to be the most prolific producers here. Production from the middle and upper porous breaks is difficult to assess because production from all zones is comingled.

Drilling surrounding the Hippen #1 lease established good production in neighboring locations. The most prolific cumulative production to date has been in Section 36, T1S, R4W, and Section 31, T1S, R3W, on the Crooks and Wagner leases, which have been subject to periodic vacuum pump recovery. Approximately 65% of the total crude oil produced from Buckhorn Consolidated has come from wells on these leases, and high production there is assumed to be linked to use of vacuum pumping to improve oil recovery. Over 200 wells have reported production at Buckhorn Consolidated, but many of these wells were apparently non-economic wells, because no commercial production is known for many wells reported as producers.

---

**STOP 4 Little Missouri and McKee Creeks** (NW, SW, SE, Sec. 20, T2S, R4W, 4th P.M., Fishhook 7.5-Minute Quadrangle, Brown County) (fig. 19).

---

We will examine exposures of Warsaw Formation shales and limestones and discuss the geology of Little Missouri and McKee Creeks. Walk along the east bank of Little Missouri Creek to where it enters McKee Creek, and then follow McKee Creek downstream to an exposure of the Warsaw on the outside of a large U-shaped meander (see route map).

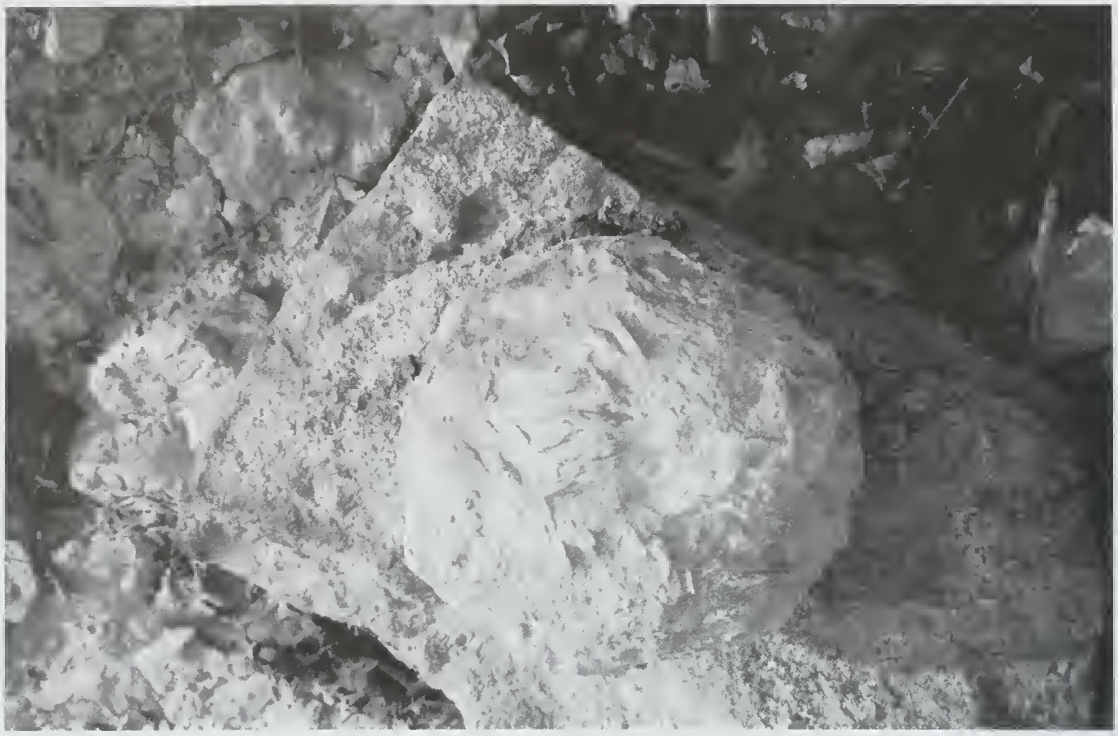


**Figure 19** Solid geode from the Mississippian-age Warsaw Formation showing blades of calcite crystals – Stop 4 (photo by W. T. Frankie).

**STOP 5 LUNCH: Siloam Springs State Park – Main Shelter House**

## Geologic Maps – How They Help Society

Geologic maps are practical tools (1) for the display of information about the rocks and deposits beneath the ground, (2) for interpretation of natural conditions and hazards, (3) for assessment and management of land and water resources, and (4) for education.

Geologic maps are used to synthesize a broad range of information about the geology of an area into readily usable form. Geologic maps provide information that can be used for many purposes as we seek to utilize the land we live on. Using geologic maps, we can discover the consequences of past actions and provide direction for prudent future choices. Knowledge of the past—as it is recorded in the landscape, rocks, soils, fluids, and fossils and represented on geologic maps—can be used to reconstruct Earth's history. Subtle and intricate geologic clues allow us to discover what happened, when, where, and why. Geologic maps help us understand the effects of past climates and help predict how climate change may affect Illinois. Geologic maps reveal the patterns of past evolution of the landscape by showing the location and physical properties of deposits and their relative ages and manner of formation. From them, we can infer the shifting of river channels and coastlines, the rise and fall of lake levels, the origin and demise of wetlands, the effects of floods and earthquakes, and the location of groundwater, fossil fuels, and other resources. The critical components of the geology of our environment must be understood so that we can wisely use and safely coexist with our natural surroundings long into the future.
Frequent users of geologic maps include government decision makers, planners, engineers, teach-

Frequent users of geologic maps include government decision makers, planners, engineers, teachers, students, scientists, homeowners, developers, hikers, and other members of the public. The geologic maps most useful to these groups are those that show detail in small areas. The ISGS has embarked on a long-term program to map the geology of the entire state at a scale of 1:24,000 (1 inch on the map = 2,000 feet on the ground). This scale provides enough detail to be useful for planning land use and managing natural resources.

## Map Scales

The word *scale* as applied to maps relates the distance on a map with the corresponding distance on the ground. It can be expressed either as a ratio of two numbers or as a bar scale. Scale is used in both general and specific ways.

The general usage can be illustrated by the phrase "statewide scale," which implies mapping that shows the entire state. The Illinois State Geological Survey most commonly publishes its statewide maps at scale of 1:500,000. On such maps, the dimensions of Illinois are about 28 inches from east to west and 48 inches from north to south.

The ratio 1:500,000 means that one unit on a map represents 500,000 such units on the ground. For example, 1 inch on a map represents 500,000 inches (nearly 8 miles) on the ground. A bar scale (often appearing as a horizontal line on a map) indicates this relationship visually.

Maps with scales of 1:100,000 (about 1.5 miles to the inch) are commonly used for countywide maps. For a particular site and its vicinity, mapping will be at a much larger scale. The most commonly used topographic quadrangle maps issued by the U. S. Geological Survey are those published at a scale of 1:24,000 (1 inch equals 2,000 feet, or a little less than 0.4 of a mile); this map scale is suitable for many uses.

The terms *small scale* and *large scale* are often used to compare maps of different scales. A statewide map, such as a map at a scale of 1:500,000, is a small-scale map compared to a county map at a scale of 1:100,000. Less detail can be shown on the smaller-scale map because the area represented is larger in comparison to the large-scale map. More detail can be shown on a large-scale map because the area represented is smaller and can be shown in much more detail. Another way to understand scale is to consider what the thickness of a pencil line represents on a map. On a large-scale map of 1:24,000, for example, ½ inch on the map equals about 1,000 feet on the surface. Therefore, the thickness of an ordinary pencil line would actually represent about 20 feet on the ground. On a small-scale map of 1:500,000, on the other hand, the thickness of a pencil line would represent between 600 and 700 feet on the ground.

The important thing to remember about the scale of a map and the thickness of lines that separate geologic units on a map is that scale can make a very great difference if one is trying to locate very precisely a boundary of a unit. Most boundaries on maps are drawn in general terms, delineating the extent of a unit by inference from one exposure or drill core to another, and usually taking the configuration of the ground surface into consideration. The lines marking boundaries on a map, therefore, are estimates based on a geologist's experience and expert reading of the landscape. To enlarge an area of a small-scale map with its lines and say that a particular boundary crosses one's property, therefore, is taking a great deal of liberty with map scales and cannot by any means be considered accurate. The easiest way to demonstrate this is to consider, as we did above, what the thickness of a pencil line represents on a map, depending on the scale of the map.

**Figure 20** Exposure of the Mississippian-age Warsaw Formation along Lanes Branch – Stop 6 (photo by W. T. Frankie).

---

**STOP 6 Lanes Branch – Left Fork** (NW, NW, SW, Sec. 3, T3S, R5W, 4th P.M., Fishhook 7.5-Minute Quadrangle, Adams County). We will examine the Warsaw Formation and collect geodes.

---

The Warsaw Formation is exposed along Lanes Branch, in the stream bed and lower portions of the valley walls (fig. 20). The Warsaw is not exposed everywhere; it is unconformably overlain by Pennsylvanian rocks. Just downstream and north of where we will actually examine the Warsaw, thick sandstones at the base of the Tradewater Formation fill deep erosional channels that cut deeply into the Mississippian rocks. (All the Chesterian Series and of the Valmeyeran Series down to the upper part of the Warsaw are missing here.) While we will not see these Tradewater sandstones and the unconformity exposed at this stop, we will see pieces of Pennsylvanian sandstone float (pieces of rock that have washed downstream) in the stream (along with Warsaw sediments, including geodes). However, to the east as we leave the stop, we will actually see an exposure of Colchester Coal and the black, overlying Mecca Quarry Shale on the left side of the road about 20 feet up the steep rise out of the valley, showing that some of the Pennsylvanian does overlie the Warsaw along this valley. We have already seen this coal and black shale at Stop 1.

We will be collecting in the stream gravels, which contain float eroded from the Middle Mississippian Warsaw Formation and the Pennsylvanian Tradewater and Carbondale Formations. We will find a large number of geodes weathered out from the Warsaw, as well as pieces of thin-bedded fossiliferous limestones. This limestone contains many types of marine fossils, including crinoids and other echinoderms, bryozoans, many types of brachiopods, and some corals. This stop will be

the first of two that offers an opportunity to collect fossils and geodes from the Warsaw. Some of the geodes contain some very beautiful crystals and minerals.

In the gravel bed of Lanes Branch, we will also see pieces of the marine black shales and limestones that came from the formation overlying the Colchester Coal. These rocks also contain marine fossils that you may wish to collect.

Upstream from the road is a cutbank exposure of Warsaw Formation shales and thin limestones. The lower half to two-thirds of the Warsaw consists largely of shales and thin shaley but very fossiliferous limestones (grainstones). Most of the geodes that make the Warsaw well known to collectors are found in this part of the formation. We can see the upper part of the formation overlying the shales at the next stop, where much thicker limestones (grainstones) representing carbonate sand banks made of marine skeletal materials (bryozoans, brachiopods, and echinoderms) form thick, ledge-forming limestones. These limestones are of interest because they constitute a potential resource for high-quality limestone products. In some areas, these thick Warsaw carbonates are over 30 feet thick.

---

**STOP 7 Fishhook Creek** (NW, NE, SE, Sec. 2, T3S, R5W, 4th P.M., Fishhook 7.5-Minute Quadrangle, Adams County). We will examine Warsaw Formation limestones and shales exposed in the creek. Opportunity to collect geodes and fossils.

---

The upper portion of the Warsaw Formation is exposed all along Fishhook Creek at this location. Nearby in some exposures higher up on the hill slopes, the basal Pennsylvanian rests directly on the Warsaw. In this area, the Warsaw Formation is up to 100 feet thick and consists of light to medium gray or blue-gray shale interbedded with finely crystalline, argillaceous dolomite and light gray to olive gray (rusty to yellow-orange where weathered) fossiliferous limestones (grainstones). The limestone is locally dolomitic, in part. Generally, shale is the predominant lithology in the lower two-thirds of the Warsaw, whereas limestone and dolomite primarily occur in the upper part. Thin limestone layers (grainstones) are scattered throughout the unit, but limestones commonly form one or more massive ledges in the upper part of the Warsaw, especially along portions of McKee Creek and Fishhook Creek.

Downstream to the west and northwest, several exposures show the overall nature of the Warsaw Formation. In several steep stream cuts, we can see the upper carbonate limestone beds resting on the more shaley lower portions that contain the thin, interbedded grainstones and geodes (fig. 21). West of the bridge, the lower portions consist primarily of shale and thin, interbedded grainstones (coarse-grained limestones).

Among the fossils contained in the Warsaw are very abundant bryozoans, common brachiopods, gastropods, and echinoderms such as crinoids and echinoids (sea urchins). This location offers the best opportunity of the field trip to collect these abundant marine fossils. We encourage you to spend some time looking along the creek to the northwest of the bridge, where abundant fossils can be found in the thin grainstones exposed in the creek and in pieces of float in the channel bars. Geodes are moderately abundant in the formation and can be found at this location (fig. 22). They occur especially in the middle, more shaley intervals and vary from hand-sized to basketball-sized specimens. Here, the larger specimens are found in the stream floor just northwest of the bridge. The larger specimens are heavy and may be solid, while the hollow, crystal-lined geodes are found among the smaller specimens.

**Figure 21** Exposure of Warsaw Formation limestones and geodes in creek bed – Stop 7 (photo by W. T. Frankie).

**Figure 22** Large geode with crystals within the Warsaw Formation limestone in the bed of Fishhook Creek – Stop 7 (photo by W. T. Frankie).

# Appendix: Siloam Springs West and Greenwood School South Sections

**Siloam Springs West Section** (SW, SE, SE, Sec. 15, T2S, R5W, Kellerville 7.5-Minute Quadrangle, Adams County). Illinois and Wisconsin Episode glacial silts. This description is adapted from the *Mt. Sterling Area Geological Science Field Trip Guide Leaflet, 1971-E.* The older terminology has been changed to reflect current use of names.

**Wisconsin Episode**

Peoria Silt

Loess – Massive, leached, mottled tan and gray; surface soil in top; 4' 6"
Loess – Massive, leached, mottled light tan-brown and gray-tan; 6"

Roxana Silt – Massive, leached, medium tan-brown with mottlingof gray-tan; contains some clay and very fine sand; gradational contacts; 3'

**Illinois Episode**

Loveland Silt

Sangamon Geosol – Sand, very fine to fine; silt with some clay; massive, leached, yellow-tan at base grading upward to red-brown in B horizon of Sangamon Geosol; extends to bottom of road ditch; 3'

This exposure is about a mile west of the Mendon Moraine, which is the end moraine marking the limit of glaciation of the Illinois Episode. At the town of Mendon, 20 miles northwest of here, the moraine is a conspicuous ridge; but in this area, it is a discontinuous, indistinct feature. A line that would delineate the Mendon Moraine can, for several reasons, be drawn along the east slopes of McKee and Fishhook Creeks. No Illinois Episode tills are found west of this boundary. Illinois Episode proglacial lake deposits found along McKee Creek show that the valley of an east-flowing stream was dammed by the earliest Illinois Episode glacier near our present position. Several exposures, like this one, show the Loveland Silt with a Sangamon Geosol development. Since this relationship is typically found beyond the limits of Illinois Episode glaciation, the boundary is drawn east of these exposures. It is also likely that the courses of McKee and Fishhook Creeks were aligned by the Mendon Moraine when it was a more prominent topographic feature; they probably flowed along its front.

The beds in this exposure are silts largely transported by wind from the outwash of the Illinois and Wisconsin Episode glaciers. The Loveland Silt is the lowermost unit and was probably deposited continuously during the Illinois Episode glaciation. Some deposits of the silt laid down ahead of the advancing ice were overridden. The Loveland Silt in the cut here was a surface deposit and was weathered during the Sangamon interglacial episode. Since the ditch shows only the soil zone developed on the Loveland Silt, the unit is called the Sangamon Geosol.

The Sangamon Geosol is a weathered zone developed on many types of surfaces, including bedrock. The B horizon remarked in the description refers to a system of describing soil horizons. The A horizon of a soil is the top layer, a clay-depleted layer rich in organic material. The A horizon is depleted of clays because they have been washed down by weathering. The underlying B horizon is enriched with clays from the A horizon.

The Roxana Silt is a windblown silt that accumulated at the beginning of the Wisconsin Episode glaciation, so it may be found, as it is here, bedded between two silts or loesses or, where it was overridden by the glacier, beneath till. (See the figure "Sequence of Glaciations and Interglacial Drainage in Illinois," in *Pleistocene Glaciations in Illinois* in the back of the Guidebook, for the relationship of this section to the position of the various glacial lobes.) The source of the silt was the valley train of the Ancient Mississippi River, the valley of which is now occupied by the Illinois River between St. Louis and the Big Bend of the Illinois. The Roxana Silt is widespread in the area outside Wisconsin Episode drift and generally composes 20% to 30% of the loess thickness there.

The Peoria Silt (loess) at the top of the exposure was deposited during the latter part of the Wisconsin Episode glaciation. This loess averages 5 feet thick over 90% of the state. Like the other units in this exposure, the loess intertongues with tills east of here in central Illinois, where it was deposited in the path of the advancing Wisconsin glacier, which overrode and buried it. In places where the loess interfingers with till, the loess above the till was previously named the Richland Loess. The Richland Loess is now classified as part of the Peoria Silt. The loess which occurs below the Wisconsin till, previously called Morton Loess, has been reclassified as the Morton Tongue of the Peoria Silt.

Outside the area of Wisconsin till, 65% to 75% of the loess is Peoria Silt. This extraordinary volume of loess was derived from large quantities of outwash deposited when the Wisconsin glaciers blocked the courses of several ancient rivers, which evidently diverted the Ancient Mississippi and Ancient Ohio Rivers into their present courses.

**Greenwood School South Section** (SW, SW, NW, Sec. 36, T. 2S, R. 5 W, Fishhook 7.5-Minute Quadrangle, Adams County). Pleistocene deposits exposed in cutbank on east side of road. This description is adapted from the *Mt. Sterling Area Geological Science Field Trip Guide Leaflet, 1971-E.* Some of the older terminology has been changed to reflect current use of names.

**Wisconsin Episode**

Peoria Silt

Loess – Massive, leached, light tan-brown; surface soil; 1' ; grades down into:
Loess – Massive, leached, medium brown with slight reddish cast; more silty than above; 1' 6"

**Illinois Episode**

Teneriffe Silt – Medium brown with reddish cast, darker than above and more sandy and clayey; weathered surface is lighter colored and exhibits crust having only very fine polygonal cracking; Sangamon Geosol; 1' 4"

Glasford Formation – Kellerville Till Member; medium dark brown mottled with some yellow-brown, more sandy, clayey, and tougher than silt above; contains irregular blotches and streaks of light gray sand; occasional small iron-manganese speck noted; weathers as distinctive light rusty brown streak across outcrop; Sangamon Geosol; 9"

Petersburg Silt

Silt – Light gray and yellow gray mottled, tight, very tough, clayey; some black iron-manganese nodules and staining on joints; nodules increase downward; lower part of exposure shows rusty brown and light gray mottling; surface shows persistent fine polygonal cracks; about 1' below top rusty brown iron-manganese nodules cover surface; Sangamon Geosol; 2' 6"

Silt – Rusty brown with occasional light gray mottling; iron-manganese nodules present; not as tight and compact as silt above; 4"

**Pre-Illinois Episode**

Wolf Creek Formation

Till – Rusty brown and light gray mottled; weathers as distinct gray-brown horizon across exposure; iron-manganese nodules and streaks abundant; clayey; fairly tight and compact; leached; coarse polygonal cracking on weathered surface; Yarmouth Geosol; 1' 1"

Till – Medium to dark yellow-brown; contains pebbles and cobbles that increase in abundance downward; bottom 4.5 to 5 feet of very gravelly material that looks like outwash is fairly fresh and contains igneous, metamorphic, and sedimentary rocks, including pieces of geodes; base not exposed; 7' +

As igneous rocks are decomposed by weathering processes, clay minerals, among other materials, are formed. These minerals, which are mica-like silicates with varying compositions, are very fine grained, the grains being generally less than 5 microns. Because of their extremely small size, identification of these minerals with any degree of certainty is difficult except by the use of X-ray, optical, chemical, or other special laboratory techniques.

The clay minerals in the glacial deposits here were identified by X-ray analysis, and they aid in deciphering the sequence of Pleistocene events. According to the results of earlier investigations, the pre-Illinois glacial episode brought material from the north and northwest that contained a high percentage of the clay mineral montmorillonite. Because the tills exposed in the lower part of the bank contain a high percentage of montmorillonite, they are probably pre-Illinois episode.

The overlying Petersburg Silt represents a transition from pre-Illinois to Illinois episode materials. This silt has a fairly high percentage of montmorillonite, which decreases upward, as could be predicted because the silts are derived in part from reworked pre-Illinois episode drift. The clay mineral illite has been identified as coming into this area from the northeast via the Illinois Episode glacier. Meltwater flowing away from the advancing glacier carried illite out across the pre-Illinois till plains, where it became mixed with montmorillonite. As the Illinois Episode glacier approached, more illite-bearing material was available, and the silts that were deposited became increasingly rich in this clay mineral. The overlying Kellerville Till Member has a high percentage of illite, as do the rest of the overlying younger materials. The clay mineral composition of the Teneriffe Silt is almost identical with that of the Kellerville because it was derived in large part from reworking of that till.

# References


Bergstrom, R.E., and A.J. Zeizel, 1957, Groundwater Geology in Western Illinois, South Part: Illinois State Geological Survey, Circular 232, 28 p.

Bergstrom, R.E., ed., 1968, The Quaternary of Illinois: University of Illinois at Urbana-Champaign, College of Agriculture, Special Publication 14, 179 p.

Buschbach, T.C., and D.R. Kolata, 1991, Regional setting of the Illinois Basin, *in* M.W. Leighton, D.R. Kolata, D.F. Oltz, and J.J. Eidel, eds. Interior Cratonic Basins: American Association of Petroleum Geologists, Memoir 51, p. 29–55.

Cloos, M., and J. Baxter, 1981, Subsurface Variation in the High-Calcium Dolbee Creek Limestone in Western Illinois: Illinois State Geological Survey, Industrial Mineral Notes 78, 23 p.

Collinson, C.W., D.H. Swann, and H.B. Willman (leaders), 1954, Guide to the Structure and Paleozoic Stratigraphy along the Lincoln Fold in Western Illinois: Field Conference held in connection with the 39th annual convention of the American Association of Petroleum Geologists, St. Louis, MO, Illinois Geological Survey, 75 p.

Goodwin, J.H., and R.D. Harvey, 1980, Limestone Resources of Adams and Brown Counties: Illinois State Geological Survey, Circular 512, 20 p.

Herzog, B.L., B.J. Stiff, C.A Chenoweth, K.L. Warner, J.B. Sieverling, and C. Avery, 1994, Buried Bedrock Surface of Illinois: Illinois State Geological Survey, Illinois Map 5; scale, 1:500,000; size, 33.25" x 60.75".

Horberg, C.L., 1950, Bedrock Topography of Illinois: Illinois State Geological Survey, Bulletin 73, 111 p.

Horberg, L., 1956, Pleistocene Deposits along the Mississippi Valley in Central-Western Illinois: Illinois State Geological Survey, Report of Investigations 192, 39 p.

Howard, R.H., 1960, Oil and Gas in the Adams–Brown–Schuyler County Area, Illinois: Illinois State Geological Survey Circular 325, 23 p.

Huff, B.G., 1988, Oil and Gas Developments in Illinois, 1988: Illinois State Geological Survey, Illinois Petroleum 154, 72 p.

Killey, M.M., 1998, Illinois' Ice Age Legacy: Illinois State Geological Survey, GeoScience Education Series 14, 66 p.

Lasemi, Z., R.D. Norby, J.A. Devera, B.W. Fouke, H.E. Leetaru, and F.B. Denny, 1999, Middle Mississippian Carbonates and Siliciclastics in Western Illinois: Illinois State Geological Survey, Guidebook 31, 60 p.

Leighton, M.M., G.E. Ekblaw, and C.L. Horberg, 1948, Physiographic Divisions of Illinois: Illinois State Geological Survey, Report of Investigations 129, 19 p.

Lineback, J.A., et al., 1979, Quaternary Deposits of Illinois: Illinois State Geological Survey Map; scale, 1:500,000; size, 40" x 60"; color.

Nelson, J.W., 1995, Structural Features in Illinois: Illinois State Geological Survey, Bulletin 100, 144 p.

Piskin, K., and R.E. Bergstrom, 1975, Glacial Drift in Illinois: Illinois State Geological Survey, Circular 490, 35 p.

Reinertsen, D.L., 1964, Strippable Coal Reserves of Illinois. Part 4—Adams, Brown, Calhoun, Hancock, McDonough, Pike, Schuyler, and the southern parts of Henderson and Warren Counties: Illinois State Geological Survey Circular 374, 32 p.

Reinertsen, D.L., D.J. Berggren, and M.M. Killey, 1971, Mt. Sterling Area: Illinois State Geological Survey, Geological Science Field Trip Guide Leaflet 1971, 30 p., plus attachments.

Schwegman, J.E., 1973, Comprehensive Plan for the Illinois Nature Preserve System. Part 2—Natural Divisions of Illinois: Illinois Nature Preserves Commission, Springfield, IL, 32 p.

White, W.A., 1963, Buff-Burning Clay Resources of Western Illinois: Illinois State Geological Survey Circular 353, 23 p.

Willman, H.B., et al., 1967, Geologic Map of Illinois: Illinois State Geological Survey Map; scale, 1:500,000; size, 40" x 56"; color.

Willman, H.B., J.A. Simon, B.M. Lynch, and V.A. Langenheim, 1968, Bibliography and Index of Illinois Geology through 1965: Illinois State Geological Survey, Bulletin 92, 373 p.

Willman, H.B., and J.C. Frye, 1970, Pleistocene Stratigraphy of Illinois: Illinois State Geological Survey, Bulletin 94, 204 p.

Willman, H.B., E. Atherton, T.C. Buschbach, C. Collinson, J.C. Frye, M.E. Hopkins, J.A. Lineback, and J.A. Simon, 1975, Handbook of Illinois Stratigraphy: Illinois State Geological Survey, Bulletin 95, 261 p.

# Glossary

The following definitions are adapted in total or in part from several sources; the principal source is R.L. Bates and J.A Jackson, eds., *Glossary of Geology*, 3rd ed.: American Geological Institute, Alexandria, VA, 1987, 788 p.

**Ablation** - Separation and removal of rock material and formation of deposits, especially by wind action or the washing away of loose and soluble materials.

**Age** - An interval of geologic time; a division of an epoch.

**Aggrading stream** - One that is actively depositing sediment in its channel or floodplain because it is being supplied with more load than it can transport.

**Alluviated valley** - One that has been at least partially filled with sand, silt, and mud by flowing water.

**Alluvium** - A general term for clay, silt, sand, gravel, or similar unconsolidated sorted or semisorted sediment deposited during comparatively recent time by a stream or other body of running water.

**Anticline** - A convex-upward rock fold in which strata have been bent into an arch; the strata on either side of the core of the arch are inclined in opposite directions away from the axis or crest; the core contains older rocks than does the perimeter of the structure.

**Aquifer** - A geologic formation that is water-bearing and which transmits water from one point to another.

**Argillaceous** - Said of rock or sediment that contains, or is composed of, clay-sized particles or clay minerals.

**Arenite** - A relatively clean quartz sandstone that is well sorted and contains less than 10% argillaceous material.

**Base level** - Lower limit of erosion of the land's surface by running water. Controlled locally and temporarily by the water level of stream mouths emptying into lakes, or more generally and semipermanently by the level of the ocean (mean sea level).

**Basement complex** - The suite of mostly crystalline igneous and/or metamorphic rocks that generally underlies the sedimentary rock sequence.

**Basin** - A topographic or structural low area that generally receives thicker deposits of sediments than adjacent areas; the low areas tend to sink more readily, partly because of the weight of the thicker sediments; the term also denotes an area of relatively deep water adjacent to shallow-water shelf areas.

**Bed** - A naturally occurring layer of earth material of relatively greater horizontal than vertical extent that is characterized by physical properties different from those of overlying and underlying materials. It also is the ground upon which any body of water rests or has rested, or the land covered by the waters of a stream, lake, or ocean; the bottom of a stream channel.

**Bedrock** - The solid rock (sedimentary, igneous, or metamorphic) that underlies the unconsolidated (non-indurated) surface materials (for example, soil, sand, gravel, glacial till, etc.).

**Bedrock valley** - A drainageway eroded into the solid bedrock beneath the surface materials. It may be completely filled with unconsolidated (non-indurated) materials and hidden from view.

**Braided stream** - A low-gradient, low-volume stream flowing through an intricate network of interlacing shallow channels that repeatedly merge and divide, and are separated from each other by branch islands or channel bars. Such a stream may be incapable of carrying all of its load. Most streams that receive more sediment load than they can carry become braided.

**Calcarenite** - Describes a limestone composed of more or less worn fragments of shells or pieces of older limestone. The particles are generally sand-sized.

**Calcareous** - Said of a rock containing some calcium carbonate ($CaCO_3$), but composed mostly of something else; (synonym: limey).

**Calcining** - The heating of calcite or limestone to its temperature of dissociation so that it loses its carbon dioxide; also applied to the heating of gypsum to drive off its water of crystallization to make plaster of paris.

**Calcite** - A common rock-forming mineral consisting of $CaCO_3$; it may be white, colorless, or pale shades of gray, yellow, and blue; it has perfect rhombohedral cleavage, appears vitreous, and has a hardness of 3 on the Mohs scale; it effervesces (fizzes) readily in cold dilute hydrochloric acid. It is the principal constituent of limestone.

**Chert** - Silicon dioxide ($SiO_2$); a compact, massive rock composed of minute particles of quartz and/or chalcedony; it is similar to flint, but lighter in color.

**Clastic** - Said of rocks composed of particles of other rocks or minerals, including broken organic hard parts as well as rock substances of any sort, transported and deposited by wind, water, ice or gravity.

**Closure** - The difference in altitude between the crest of a dome or anticline and the lowest structural or elevation contour that completely surrounds it.

**Columnar section** - A graphic representation, in the form of one or more vertical column(s), of the vertical succession and stratigraphic relations of rock units in a region.

**Conformable** - Said of strata deposited one upon another without interruption in accumulation of sediment; beds parallel.

**Delta** - A low, nearly flat, alluvial land form deposited at or near the mouth of a river where it enters a body of standing water; commonly a triangular or fan-shaped plain extending beyond the general trend of a coastline.

**Detritus** - Loose rock and mineral material produced by mechanical disintegration and removed from its place of origin by wind, water, gravity, or ice; also, fine particles of organic matter, such as plant debris.

**Disconformity** - An unconformity marked by a distinct erosion-produced irregular, uneven surface of appreciable relief between parallel strata below and above the break; sometimes represents a considerable time interval of nondeposition.

**Dolomite** - A mineral, calcium-magnesium carbonate ($Ca,Mg[CO_3]_2$); also the name applied to sedimentary rocks composed largely of the mineral. It is white, colorless, or tinged yellow, brown, pink, or gray; has perfect rhombohedral cleavage; appears pearly to vitreous; effervesces feebly in cold dilute hydrochloric acid.

**Drift** - All rock material transported by a glacier and deposited either directly by the ice or reworked and deposited by meltwater streams and/or the wind.

**Driftless Area** - A 10,000-square-mile area in northeastern Iowa, southwestern Wisconsin, and northwestern Illinois where the absence of glacial drift suggests that the area may not have been glaciated.

**End moraine** - A ridge or series of ridges formed by accumulations of drift built up along the outer margin of an actively flowing glacier at any given time; a moraine that has been deposited at the lower or outer end of a glacier.

**Epoch** - An interval of geologic time; a division of a period. (Example: Pleistocene Epoch).

**Era** - The unit of geologic time that is next in magnitude beneath an eon; it consists of two or more periods. (Example: Paleozoic Era).

**Escarpment** - A long, more or less continuous cliff or steep slope facing in one general direction; it generally marks the outcrop of a resistant layer of rocks, or the exposed plane of a fault that has moved recently.

**Fault** - A fracture surface or zone of fractures in Earth materials along which there has been vertical and/or horizontal displacement or movement of the strata on opposite sides relative to one another.

**Flaggy** - Said of rock that tends to split into layers of suitable thickness for use as flagstone.

**Flood plain** - The surface or strip of relatively smooth land adjacent to a stream channel produced by the stream's erosion and deposition actions; the area covered with water when the stream overflows its banks at times of high water; it is built of alluvium carried by the stream during floods and deposited in the sluggish water beyond the influence of the swiftest current.

**Fluvial** - Of or pertaining to a river or rivers.

**Formation** - The basic rock unit, one distinctive enough to be readily recognizable in the field and widespread and thick enough to be plotted on a map. It describes the strata, such as limestone, sandstone, shale, or combinations of these and other rock types. Formations have formal names, such as Joliet Formation or St. Louis Limestone (Formation), generally derived from the geographic localities where the unit was first recognized and described.

**Fossil** - Any remains or traces of a once-living plant or animal preserved in rocks (arbitrarily excludes Recent remains); any evidence of ancient life. Also used to refer to any object that existed in the geologic past and for which evidence remains (for example, a fossil waterfall)

**Friable** - Said of a rock or mineral that crumbles naturally or is easily broken, pulverized, or reduced to powder, such as a soft and poorly cemmented sandstone.

**Geology** - The study of the planet Earth that is concerned with its origin, composition, and form, its evolution and history, and the processes that acted (and act) upon it to control its historic and present forms.

**Geophysics** - Study of the Earth with quantitative physical methods. Application of the principles of physics to the study of the earth, especially its interior.

**Glaciation** - A collective term for the geologic processes of glacial activity, including erosion and deposition, and the resulting effects of such action on the Earth's surface.

**Glacier** - A large, slow-moving mass of ice formed on land by the compaction and recrystallization of snow.

**Gradient** - A part of a surface feature of the Earth that slopes upward or downward; the angle of slope, as of a stream channel or of a land surface, generally expressed by a ratio of height versus distance, a percentage or an angular measure from the horizontal.

**Igneous** - Said of a rock or mineral that solidified from molten or partly molten material (that is, from magma).

**Indurated** - Said of compact rock or soil hardened by the action of pressure, cementation and, especially, heat.

**Joint** - A fracture or crack in rocks along which there has been no movement of the opposing sides (see also Fault).

**Karst** - Collective term for the land forms and subterranean features found in areas with relatively thin soils underlain by limestone or other soluble rocks; characterized by many sinkholes separated by steep ridges or irregular hills. Tunnels and caves formed by dissolution of the bedrock by groundwater honeycomb the subsurface. Named for the region around Karst in the Dinaric Alps of Croatia where such features were first recognized and described.

**Lacustrine** - Produced by or belonging to a lake.

**Laurasia** - A protocontinent of the Northern Hemisphere, corresponding to Gondwana in the Southern Hemisphere, from which the present continents of the Northern Hemisphere have been derived by separation and continental displacement. The supercontinent from which both were derived is Pangea. Laurasia included most of North America, Greenland, and most of Eurasia, excluding India. The main zone of separation was in the North Atlantic, with a branch in Hudson Bay; geologic features on opposite sides of these zones are very similar.

**Lava** - Molten, fluid rock that is extruded onto the surface of the Earth through a volcano or fissure. Also the solid rock formed when the lava has cooled.

**Limestone** - A sedimentary rock consisting primarily of calcium carbonate (the mineral, calcite). Limestone is generally formed by accumulation, mostly in place or with only short transport, of the shells of marine animals, but it may also form by direct chemical precipitation from solution in hot springs or caves and, in some instances, in the ocean.

**Lithify** - To change to stone, or to petrify; especially to consolidate from a loose sediment to a solid rock.

**Lithology** - The description of rocks on the basis of their color, structure, mineral composition, and grain size; the physical character of a rock.

**Local relief** - The vertical difference in elevation between the highest and lowest points of a land surface within a specified horizontal distance or in a limited area.

**Loess** - A homogeneous, unstratified accumulation of silt-sized material deposited by the wind.

**Magma** - Naturally occurring molten rock material generated within Earth and capable of intrusion into surrounding rocks or extrusion onto the Earth's surface. When extruded on the surface it is called lava. The material from which igneous rocks form through cooling, crystallization, and related processes.

**Meander** - One of a series of somewhat regular, sharp, sinuous curves, bends, loops, or turns produced by a stream, particularly in its lower course where it swings from side to side across its valley bottom.

**Meander scars** - Crescent-shaped swales and gentle ridges along a river's flood plain that mark the positions of abandoned parts of a meandering river's channel. They are generally filled in with sediments and vegetation and are most easily seen in aerial photographs.

**Metamorphic rock** - Any rock derived from pre-existing rocks by mineralogical, chemical, and structural changes, essentially in the solid state, in response to marked changes in temperature, pressure, shearing stress, and chemical environment at depth in Earth's crust (for example, gneisses, schists, marbles, quartzites, etc.)

**Mineral** - A naturally formed chemical element or compound having a definite chemical composition, an ordered internal arrangement of its atoms, and characteristic crystal form and physical properties.

**Monolith** - (a) A piece of unfractured bedrock, generally more than a few meters across. (b) A large upstanding mass of rock.

**Moraine** - A mound, ridge, or other distinct accumulation of glacial drift, predominantly till, deposited in a variety of topographic land forms that are independent of control by the surface on which the drift lies (see also End Moraine).

**Morphology** - The scientific study of form, and of the structures and development that influence form; term used in most sciences.

**Natural gamma log** - One of several kinds of measurements of rock characteristics taken by lowering instruments into cased or uncased, air- or water-filled boreholes. Elevated natural gamma radiation levels in a rock generally indicate the presence of clay minerals.

**Nickpoint** - A place with an abrupt inflection in a stream profile, generally formed by the presence of a rock layer resistant to erosion; also, a sharp angle cut by currents at base of a cliff.

**Nonconformity** - An unconformity resulting from deposition of sedimentary strata on massive crystalline rock.

**Outwash** - Stratified glacially derived sediment (clay, silt, sand, gravel) deposited by meltwater streams in channels, deltas, outwash plains, on flood plains, and in glacial lakes.

**Outwash plain** - The surface of a broad body of outwash formed in front of a glacier.

**Oxbow lake** - A crescent-shaped lake in an abandoned bend of a river channel. A precursor of a meander scar.

**Pangea** - The supercontinent that existed from 300 to 200 million years ago. It combined most of the continental crust of the Earth, from which the present continents were derived by fragmentation and movement away from each other by means of plate tectonics. During an intermediate stage of the fragmentation, between the existence of Pangea and that of the present widely separated continents, Pangea was split into two large fragments, Laurasia on the north and Gondwana in the southern hemisphere.

**Ped** - Any naturally formed unit of soil structure (for example, granule, block, crumb, or aggregate).

**Peneplain** - A land surface of regional scope worn down by erosion to a nearly flat or broadly undulating plain.

**Period** - An interval of geologic time; a division of an era (for example, Cambrian, Jurassic, Tertiary).

**Physiography** - The study and classification of the surface features of Earth on the basis of similarities in geologic strucure and the history of geologic changes.

**Physiographic province (or division)** - (a) A region, all parts of which are similar in geologic structure and climate and which has consequently had a unified geologic history. (b) A region whose pattern of relief features or landforms differs significantly from that of adjacent regions.

**Point bar** - A low arcuate ridge of sand and gravel developed on the inside of a stream meander by accumulation of sediment as the stream channel migrates toward the outer bank.

**Radioactivity logs** - Any of several types of geophysical measurements taken in bore holes using either the natural radioactivity in the rocks, or the effects of radiation on the rocks to determine the lithology or other characteristics of the rocks in the walls of the borehole. (Examples: natural gamma radiation log; neutron density log).

**Relief** - (a) A term used loosely for the actual physical shape, configuration, or general unevenness of a part of Earth's surface, considered with reference to variations of height and slope or to irregularities of the land surface; the elevations or differences in elevation, considered collec-

tively, of a land surface (frequently confused with topography). (b) The vertical difference in elevation between the hilltops or mountain summits and the lowlands or valleys of a given regional extent. Formed in places where the forces of plate tectonics are beginning to split a continent. (Example: East African Rift Valley).

**Sediment** - Solid fragmental matter, either inorganic or organic, that originates from weathering of rocks and is transported and deposited by air, water, or ice, or that is accumulated by other natural agents, such as chemical precipitation from solution or secretion from organisms. When deposited, it generally forms layers of loose, unconsolidated material (for example, sand, gravel, silt, mud, till, loess, alluvium).

**Sedimentary rock** - A rock resulting from the consolidation of loose sediment that has accumulated in layers (for example, sandstone, siltstone, mudstone, limestone).

**Shoaling** - Said of an ocean or lake bottom that becomes progressively shallower as a shoreline is approached. The shoaling of the ocean bottom causes waves to rise in height and break as they approach the shore.

**Sinkhole** - Any closed depression in the land surface formed as a result of the collapse of the underlying soil or bedrock into a cavity. Sinkholes are common in areas where bedrock is near the surface and susceptible to dissolution by infiltrating surface water. Sinkhole is synonymous with "doline," a term used extensively in Europe. The essential component of a hydrologically active sinkhole is a drain that allows any water that flows into the sinkhole to flow out the bottom into an underground conduit.

**Slip-off slope** - Long, low, gentle slope on the inside of a stream meander. The slope on which the sand that forms point bars is deposited.

**Stage, substage** - Geologic time-rock units; the strata formed during an age or subage, respectively. Generally applied to glacial episodes (for example, to the Woodfordian Substage of the Wisconsinan Stage.

**Stratigraphy** - The study, definition, and description of major and minor natural divisions of rocks, particularly the study of their form, arrangement, geographic distribution, chronologic succession, naming or classification, correlation, and mutual relationships of rock strata.

**Stratigraphic unit** - A stratum or body of strata recognized as a unit in the classification of the rocks of Earth's crust with respect to any specific rock character, property, or attribute or for any purpose such as description, mapping, and correlation.

**Stratum** - A tabular or sheet-like mass, or a single, distinct layer of material of any thickness, separable from other layers above and below by a discrete change in character of the material or by a sharp physical break, or by both. The term is generally applied to sedimentary rocks, but could be applied to any tabular body of rock. (See also Bed)

**Subage** - A small interval of geologic time; a division of an age.

**Syncline** - A convex-downward fold in which the strata have been bent to form a trough; the strat on either side of the core of the trough are inclined in opposite directions toward the axis of the fold; the core area of the fold contains the youngest rocks. (See also Anticline).

**System** - A fundamental geologic time-rock unit of worldwide significance; the strata of a system are those deposited during a period of geologic time (for example, rocks formed during the Pennsylvanian Period are included in the Pennsylvanian System).

**Tectonic** - Pertaining to the global forces that cause folding and faulting of the Earth's crust. Also used to classify or describe features or structures formed by the action of those forces.

**Tectonics** - The branch of geology dealing with the broad architecture of the upper (outer) part of Earth; that is, the major structural or deformational features, their origins, historical evolution, and relations to each other. It is similar to structural geology, but generally deals with larger features such as whole mountain ranges, or continents.

**Temperature-resistance log** - A borehole log, run only in water-filled boreholes, that measures the water temperature and the quality of groundwater in the well.

**Terrace** - An abandoned floodplain formed when a stream flowed at a level above the level of its present channel and floodplain.

**Till** - Unlithified, nonsorted, unstratified drift deposited by and underneath a glacier and consisting of a heterogenous mixture of different sizes and kinds of rock fragments.

**Till plain** - The undulating surface of low relief in an area underlain by ground moraine.

**Topography** - The natural or physical surface features of a region, considered collectively as to form; the features revealed by the contour lines of a map.

**Unconformable** - Said of strata that do not succeed the underlying rocks in immediate order of age or in parallel position. A general term applied to any strata deposited directly upon older rocks after an interruption in sedimentation, with or without any deformation and/or erosion of the older rocks.

**Unconformity** - A surface of erosion or nondeposition that separates younger strata from older strata; most unconformities indicate intervals of time when former areas of the sea bottom were temporarily raised above sea level.

**Valley trains** - The accumulations of outwash deposited by rivers in their valleys downstream from a glacier.

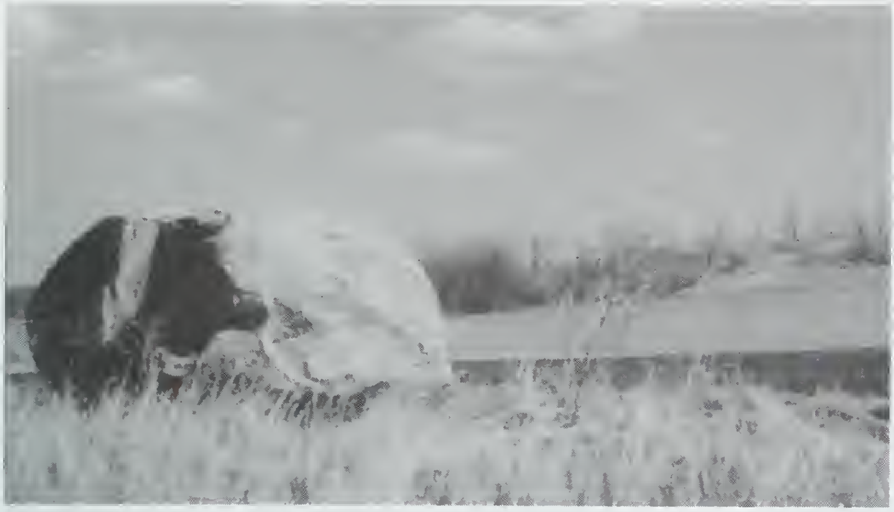
**Water table** - The point in a well or opening in the Earth where groundwater begins. It generally marks the top of the zone where the pores in the surrounding rocks are fully saturated with water.

**Weathering** - The group of processes, both chemical and physical, whereby rocks on exposure to the weather change in character, decay, and finally crumble into soil.

# ISGS Field Trip Guidebooks


$4.00 each

# EXOTIC ROCKS or Erratics Are Erratic



A piece of Canada sitting in central Illinois (photo by D. Reinertsen).

*Here and there in Illinois are boulders lying alone or with companions in the corner of a field or someone's yard, on a courthouse lawn or a schoolyard. Many of them—colorful and glittering granites, banded gneisses, and other intricately veined and streaked igneous and metamorphic rocks—seem out of place in the stoneless, grassy knolls and prairies of our state. Their "erratic" occurrence is the reason for their interesting name.*

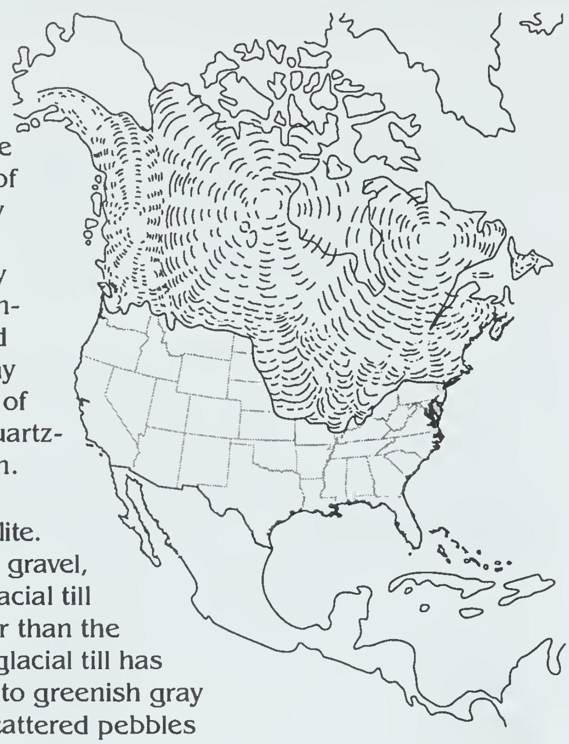
## Where did erratics come from?

These exotic rocks came from Canada and the states north of us. The continental glaciers of the Great Ice Age scoured and scraped the land surface as they advanced, pushing up chunks of bedrock and grinding them against each other or along the ground surface as the rock-laden ice sheets pushed southward.

Sometimes you can tell where the erratic originally came from by determining the kind of rock it is. A large boulder of granite, gneiss, or other igneous or metamorphic rock may have come from Canada.

Some erratics containing flecks of copper were probably transported here from the "Copper Range" of the upper peninsula of Michigan. Large pieces of copper have been found in glacial deposits of central and northern Illinois. Light gray to white quartzite boulders with beautiful, rounded pebbles of red jasper came from Ontario, Canada. Purplish pieces of quartzite, some of them banded, probably originated in Wisconsin.

Most interesting are the few large boulders of Canadian tillite. Glacial till is an unsorted and unlayered mixture of clay, sand, gravel, and boulders that vary widely in size and shape. Tillite is glacial till that was deposited by a glacier many millions of years older than the ones that invaded our state during the Great Ice Age. This glacial till has been around so long that it has been hardened into a gray to greenish gray rock containing a mixture of grains of different sizes and scattered pebbles of various types and sizes.



*Glaciers spread southward into the Midwest from two centers of ice accumulation in western and eastern Canada.*

## *How did erratics get here?*

Many boulders were probably dropped directly from the melting front of the glacier. Others may have been rafted to their present resting places by icebergs in ancient lakes or on flood-waters of some long-vanished stream as it poured from a glacier. Still others, buried in the glacial deposits, could have worked their way up to the land surface as the surrounding

*Keep an eye out for erratics. You may find some of these glacial strangers in your neighborhood.*

loose soil repeatedly froze and thawed. When the freezing ground expands, pieces of rock tend to be pushed upward, where they are more easily reached by the farmer's plow and also more likely to be exposed by erosion.

Many erratics are of notable size and beauty. Some are used as monuments in courthouse squares and parks, or along highways. Many are marked with metal plaques to indicate an interesting historical spot or event.

***Contributed by M.M. Killey***

*While on a drive through central Illinois, you may catch a glimpse of an erratic (photo by J. Dexter).*

ILLINOIS STATE GEOLOGICAL SURVEY
615 East Peabody Drive
Champaign, IL 61820-6964
217/333-4747 FAX 217/244-7004

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

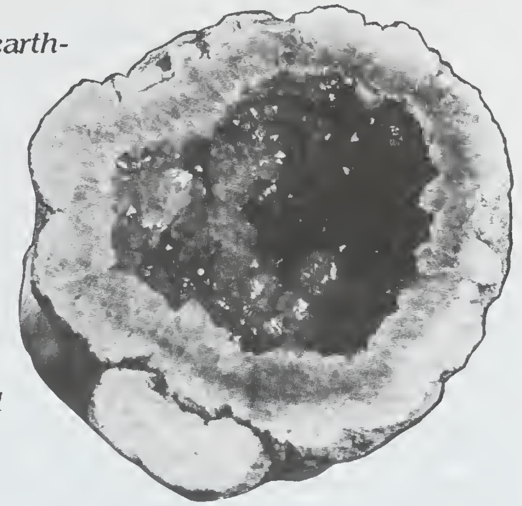
ILLINOIS STATE GEOLOGICAL SURVEY 1905

*Printed by authority of the State of Illinois/1997/1000*

printed using soybean ink on recycled paper

# Geobit 3

## GEODES—Small Treasure Vaults in Illinois



*Geodes, a term derived from a Greek word meaning earth-shaped, are irregular, roughly spherical bodies. They can be oblong or shaped like invertebrate fossils (e.g. crinoid calyx). Some are hollow and lined with beautiful layers and clusters of various mineral crystals, but others are completely filled by inward-growing crystals. Hollow geodes, relatively light-weight compared with those completely filled, are more desirable because they generally contain a greater variety of minerals that have grown well-formed crystals. Some of Illinois' most beautiful and unusual mineral specimens can be found in the crystal linings of geodes.*

### Where we find geodes

Geodes found in Illinois range from less than 1 inch to more than 2 feet in diameter, but 3 to 5 inches is the average. They generally occur in limestone, a calcium carbonate ($CaCO_3$), or in dolomite, a calcium-magnesium carbonate ($CaMg(CO_3)_2$). Although geodes can be found in carbonate-rich rocks throughout the state, one of the most famous geode collecting areas in the country is in a region of western Illinois and adjacent parts of Iowa and Missouri. The region encompasses about a 70-mile radius from the towns of Warsaw, Hamilton, and Nauvoo.

### What's in a geode?

A typical geode from western Illinois has an outer shell of chalcedony, a type of cryptocrystalline quartz composed of silicon dioxide ($SiO_2$). Once the outer shell forms, mineral-rich water still inside the shell may cause more quartz to be deposited and other minerals to form toward the center. Chalcedony, much harder than the host rock of limestone, helps to preserve the specimen during weathering. As the weaker host rock is eroded, the geodes "weather out" and remain behind. They generally are easy to see because of their shape and the texture of their outer shell.

The micro-environment inside the shell is an excellent place for crystal growth. Temperature and pressure changes, as well as evaporation, cause the mineral matter to precipitate. More solutions rich in minerals may seep into the geode later, adding to the quartz crystals or forming other minerals. In addition to the chalcedony of the outer shell, the insides of some geodes are lined with a pronounced bumpy, mammillary form of blue-gray chalcedony. Some specimens also have excellent clear quartz crystals. Ankerite, aragonite, calcite, dolomite, goethite/limonite, gypsum, and marcasite/pyrite are the other minerals most commonly found. Occasionally, dark bronze, fine, hair-like masses are found inside; these may be millerite (NiS) or a filament-like form of pyrite.

Perhaps the most fascinating geodes are those that contain petroleum, which may be under enough pressure to squirt out when the geode is broken. The enclosing rock north of Nauvoo, where these unusual geodes are found, no longer contains any significant oil. So what is the source of oil in these geodes? What is the origin of the other minerals? We don't know for sure. Perhaps trace amounts of some of the elements that make up the rarer minerals were present in shale layers associated with the carbonate strata. As a matter of fact, the most prolific zone for collecting geodes in western Illinois is in the lower part of the Warsaw Shale of the Valmeyeran Series (middle series of the Mississippian System). These sedimentary strata were deposited in shallow seas that covered what is now the midcontinent about 350 million years ago.

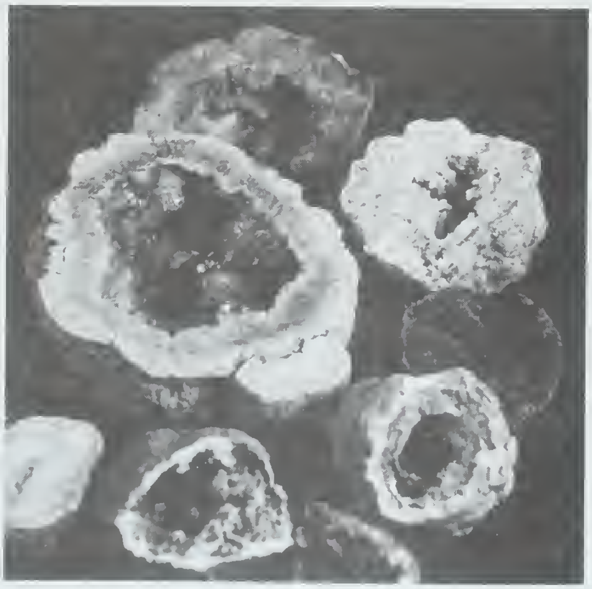
## How geodes form

Geologists have proposed several theories to explain the conditions and processes that form geodes, but none seems to be entirely adequate to explain all geode features. In discussing the origin of the western Illinois geodes, Hayes (1964) noted that any theory proposed must explain why the geodes are

- essentially confined to a specific stratigraphic interval, the lower part of the Warsaw Shale;
- usually associated with particular lithologies (clayey, shaley dolomite, and dolomitic mudstone);
- located in specific zones or beds rather than scattered randomly;
- fairly uniform in size in a particular zone and round, at least initially;
- enveloped by laminations in the bedrock that exhibit some thinning of layers above and below the specimen.

As limey sediments accumulated in shallow midcontinental seas, rounded cavities that are characteristic of geodes could not have existed at the interface or contact of water and sediments. Nor could they have existed during the earliest stages of sediment compaction and cementation. Therefore, some feature of a different texture than the host limestone had to be present. This feature either caused geodes to form or was transformed into a geode. Hayes hypothesized that the only features in the rocks that shared enough characteristics with geodes to serve as precursors were calcite concretions (small zones in the original sediment strongly cemented by calcite). The size and shape of these concretions, their position in the limestone, and their relation to the surrounding rocks are strikingly similar to those of geodes. In several exposures in the region, rock samples may be found that display all stages of the transition from concretion to geode. Hayes suggested that calcite concretions formed where organic materials (remains of the living tissues of plants or animals) accumulated with carbonate-rich sediments under quiet-water conditions. The organic matter decomposed, causing an oxygen-poor (anaerobic), alkaline environment (pH >7) to develop in the sediments. These conditions encouraged calcite to precipitate from solutions in the sediments.

The formation of many features seen in geodes may involve a step-by-step replacement of these concretions by quartz and other minerals. Changes in the chemical composition and acidity (pH) of water in the sediments caused chalcedony to replace the calcite at the outer margins of the concretions. This process caused the formation of a calcite-concretion core surrounded by a hard, but slightly permeable, shell of chalcedony. Further changes in the composition and pH of the water percolating slowly through the sediment caused the core concretion inside the geode eventually to dissolve, leaving a hard, hollow cavity in which more chalcedony, quartz, or other minerals could precipitate.



***Contributed by David L. Reinertsen, D. Scott Beaty, and Jonathan H. Goodwin***

### References


Cote, W. E., D. L. Reinertsen, G. W. Wilson, and M. M. Killey, 1970, Hamilton–Warsaw Area, Hancock County: Illinois State Geological Survey, Geological Science Field Trip Guide Leaflet 1970E and 1971B, 22 p. plus attachments.

Hayes, J.B., 1964, Geodes and concretions from the Mississippian Warsaw Formation, Keokuk region, Iowa, Illinois, Missouri: Journal of Sedimentary Petrology, v. 34, no. 1, p. 123–133.

Wathen, B., 1992, The gems of Hancock County: The Nature of Illinois, Vol. VII, No. I, p. 22–24.



Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
615 East Peabody Drive
Champaign, IL 61801-6964
(217) 333-4747



Printed by authority of the State of Illinois/1997/1000
Printed with soybean ink on recycled paper

# ANCIENT DUST STORMS IN ILLINOIS

*Myrna M. Killey*

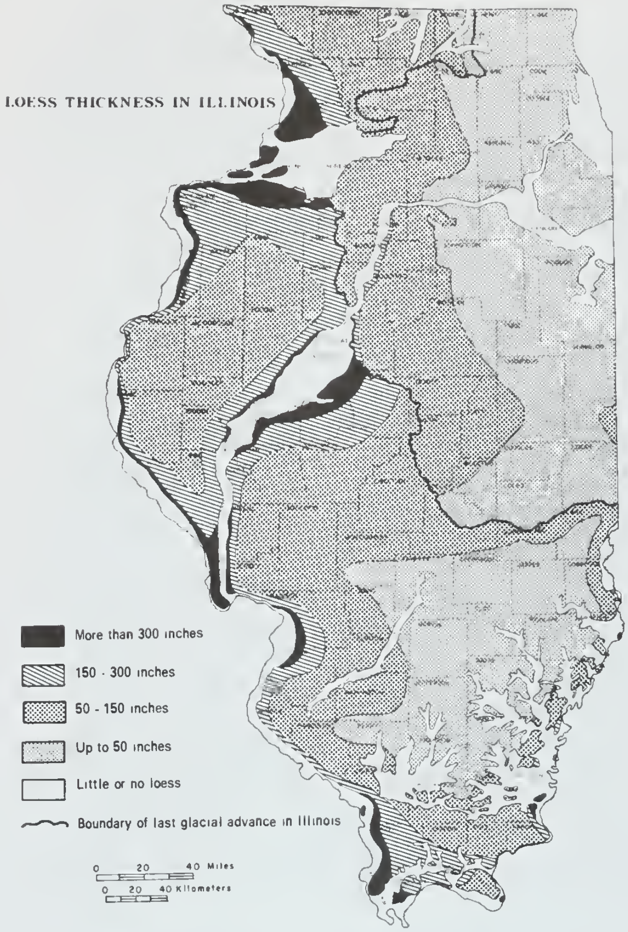
Fierce dust storms whirled across Illinois long before human beings were here to record them. Where did all the dust come from? Geologists have carefully put together clues from the earth itself to get the story. As the glaciers of the Great Ice Age scraped and scoured their way southward across the landscape from Canada, they moved colossal amounts of rock and earth. Much of the rock ground from the surface was kneaded into the ice and carried along, often for hundreds of miles. The glaciers acted as giant grist mills, grinding much of the rock and earth to "flour"—very fine dust-sized particles.

During the warm seasons, water from the melting ice poured from the glacier front, laden with this rock flour, called silt. In the cold months the meltwater stopped flowing and the silt was left along the channels the water had followed, where it dried out and became dust. Strong winds picked up the dust, swept it from the floodplains, and carried it to adjacent uplands. There the forests along the river valleys trapped the dust, which became part of the moist forest soil. With each storm more material accumulated until the high bluffs adjacent to major rivers were formed. The dust deposits are thicker along the eastern sides of the valleys than they are on the western sides, a fact from which geologists deduce that the prevailing winds of that time blew from west to east, the same direction as those of today. From such clues geologists conclude that the geologic processes of the past were much like those of today.

The deposits of windblown silt are called loess (rhymes with "bus"). Loess is found not only in the areas once covered by the glaciers but has been blown into the nonglaciated areas. The glaciers, therefore, influenced the present land surface well beyond the line of their farthest advance.

Loess has several interesting characteristics. Its texture is so fine and uniform that it can easily be identified in roadcuts—and because it blankets such a vast area many roads are cut through it. Even more noticeable is its tendency to stand in vertical walls. These steep walls develop as the loess drains and becomes tough, compact, and massive, much like a rock. Sometimes cracks develop in the loess, just as they do in massive limestones and sandstones. Loess makes good highway banks if it is cut vertically. A vertical cut permits maximum drainage because little surface is exposed to rain, and rainwater tends to drain straight down through it to the rock underneath. If the bank is cut at an angle more water soaks in, which causes the loess to slump down. Along Illinois roads the difference between a loess roadcut and one in ordinary glacial till is obvious. The loess has a very uniform texture, while the till is composed of a random mixture of rock debris, from clay and silt through cobbles and boulders.

Many loess deposits are worth a close look. Through a 10-power hand lens separate grains can be seen, among them many clear, glassy, quartz grains. Some loess deposits contain numerous rounded, lumpy stones called concretions. Their formation began when water percolating through the loess dissolved tiny




limestone grains. Some of the dissolved minerals later became solid again, gathering around a tiny nucleus or along roots to form the lumpy masses. A few such concretions are shaped roughly like small dolls and, from this resemblance, are called "loess kindchen," a German term meaning "loess children." They may be partly hollow and contain smaller lumps that make them rattle when shaken.

Fossil snails can be found in some loess deposits. The snails lived on the river bluffs while the loess was being deposited and were buried by the dust. When they are abundant, they are used to determine how old the loess is. The age is found by measuring the amount of radioactive carbon in the calcium carbonate of their shells.

Some of the early loess deposits were covered by new layers of loess following later glacial invasions. Many thousands of years passed between the major glacial periods, during which time the climate was as warm as that of today. During the warm intervals, the surface of the loess and other glacial deposits was exposed to weather. Soils developed on most of the terrain, altering the composition, color, and texture of the glacial material. During later advances of the ice, some of these soils were destroyed, but in many places they are preserved under the younger sediments. Such ancient buried soils can be used to determine when the materials above and below them were laid down by the ice and what changes in climate took place.

The blanket of loess deposited by the ancient dust storms forms the parent material of the rich, deep soils that today are basic to the state's agriculture. A soil made of loess crumbles easily and has great moisture-holding capacity. It also is free from rocks that might complicate cultivation. Those great dust storms that swirled over the land many thousands of years ago thus endowed Illinois with one of its greatest resources, its highly productive soil.

# DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS IN ILLINOIS

At the close of the Mississippian Period, about 310 million years ago, the sea withdrew from the Midcontinent region. A long interval of erosion that took place early in Pennsylvanian time removed hundreds of feet of the pre-Pennsylvanian strata, completely stripping them away and cutting into older rocks over large areas of the Midwest. Ancient river systems cut deep channels into the bedrock surface. Later, but still during early Pennsylvanian (Morrowan) time, the sea level started to rise; the corresponding rise in the base level of deposition interrupted the erosion and led to filling the valleys in the erosion surface with fluvial, brackish, and marine sands and muds.

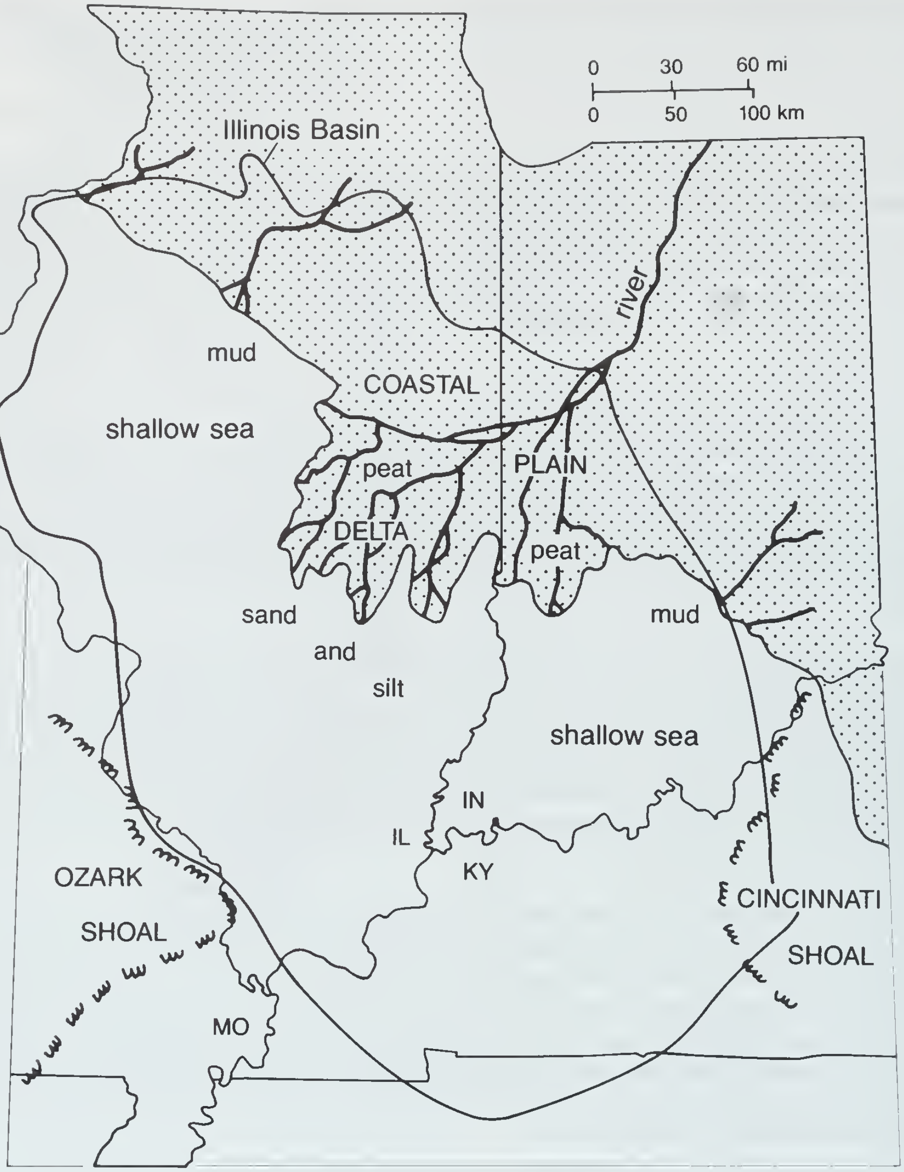
Depositional conditions in the Illinois Basin during the Pennsylvanian Period were somewhat similar to those of the preceding Chesterian (late Mississippian) time. A river system flowed southwestward across a swampy lowland, carrying mud and sand from highlands to the northeast. This river system formed thin but widespread deltas that coalesced into a vast coastal plain or lowland that prograded (built out) into the shallow sea that covered much of present-day Illinois (see paleogeographic map, next page). As the lowland stood only a few feet above sea level, slight changes in relative sea level caused great shifts in the position of the shoreline.

During most of Pennsylvanian time, the Illinois Basin gradually subsided; a maximum of about 3000 feet of Pennsylvanian sediments are preserved in the basin. The locations of the delta systems and the shoreline of the resulting coastal plain shifted, probably because of worldwide sea level changes, coupled with variation in the amounts of sediments provided by the river system and local changes in basin subsidence rates. These frequent shifts in the coastline position caused the depositional conditions at any one locality in the basin to alternate frequently between marine and nonmarine, producing a variety of lithologies in the Pennsylvanian rocks (see lithology distribution chart).

Conditions at various places on the shallow sea floor favored the deposition of sand, lime mud, or mud. Sand was deposited near the mouths of distributary channels, where it was reworked by waves and spread out as thin sheets near the shore. Mud was deposited in quiet-water areas — in delta bays between distributaries, in lagoons behind barrier bars, and in deeper water beyond the nearshore zone of sand deposition. Limestone was formed from the accumulation of limy parts of plants and animals laid down in areas where only minor amounts of sand and mud were being deposited. The areas of sand, mud, and limy mud deposition continually changed as the position of the shoreline changed and as the delta distributaries extended seaward or shifted their positions laterally along the shore.

Nonmarine sand, mud, and lime mud were deposited on the coastal plain bordering the sea. The nonmarine sand was deposited in delta distributary channels, in river channels, and on the broad floodplains of the rivers. Some sand bodies 100 or more feet thick were deposited in channels that cut through the underlying rock units. Mud was deposited mainly on floodplains. Some mud and freshwater lime mud were deposited locally in fresh-water lakes and swamps.

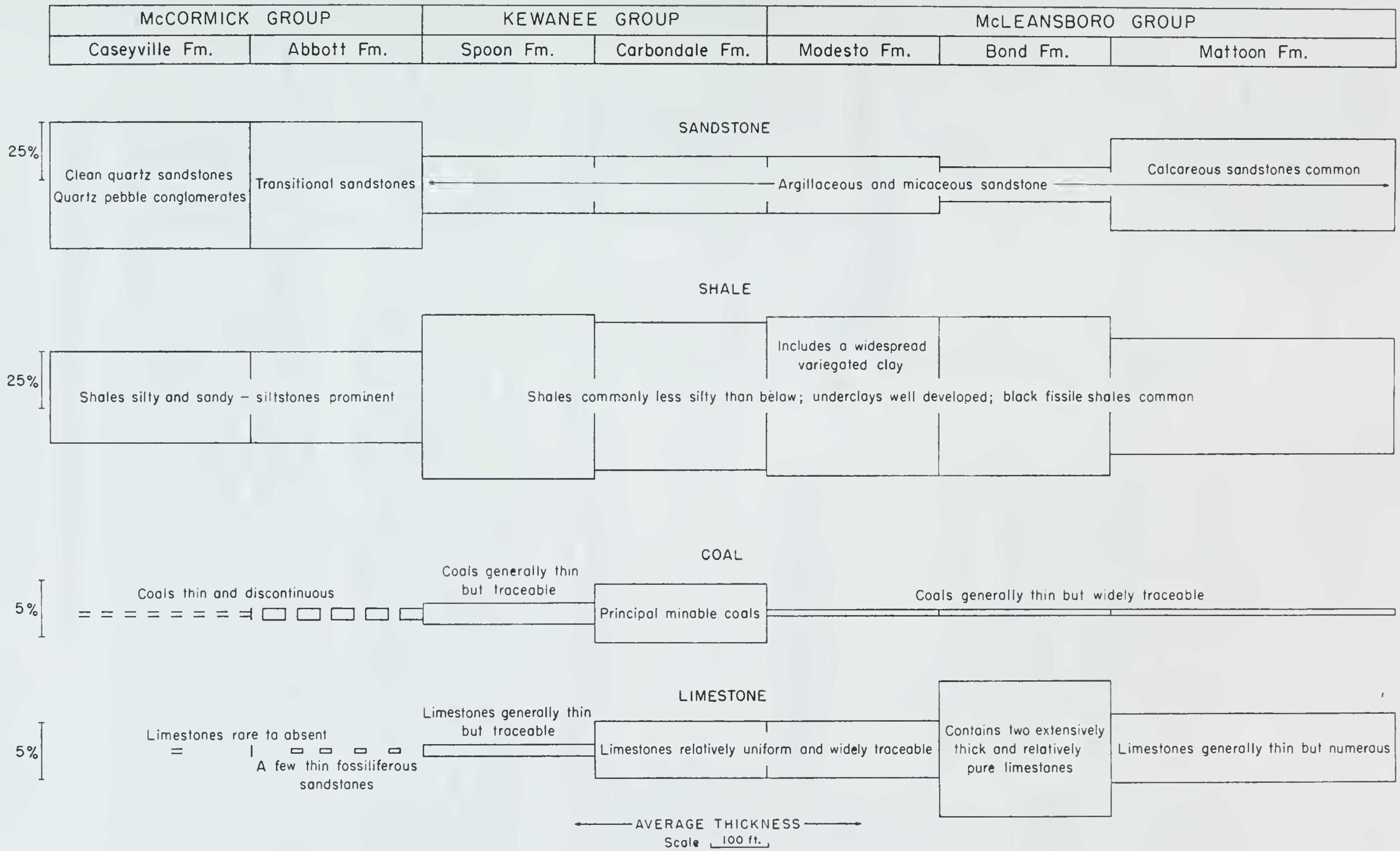
Beneath the quiet water of extensive swamps that prevailed for long intervals on the emergent coastal lowland, peat was formed by accumulation of plant material. Lush forest vegetation covered the region; it thrived in the warm, moist Pennsylvanian-age climate. Although the origin of the underclays beneath the coal is not precisely known, most evidence indicates that they were deposited in the swamps as slackwater mud before the accumulation of much plant debris. The clay underwent modification to become the soil upon which the lush vegetation grew in the swamps. Underclay frequently contains plant roots and rootlets that appear to be in their original places. The vast swamps were the culmination of nonmarine deposition. Resubmergence of the borderlands by the sea interrupted nonmarine deposition, and marine sediments were laid down over the peat.



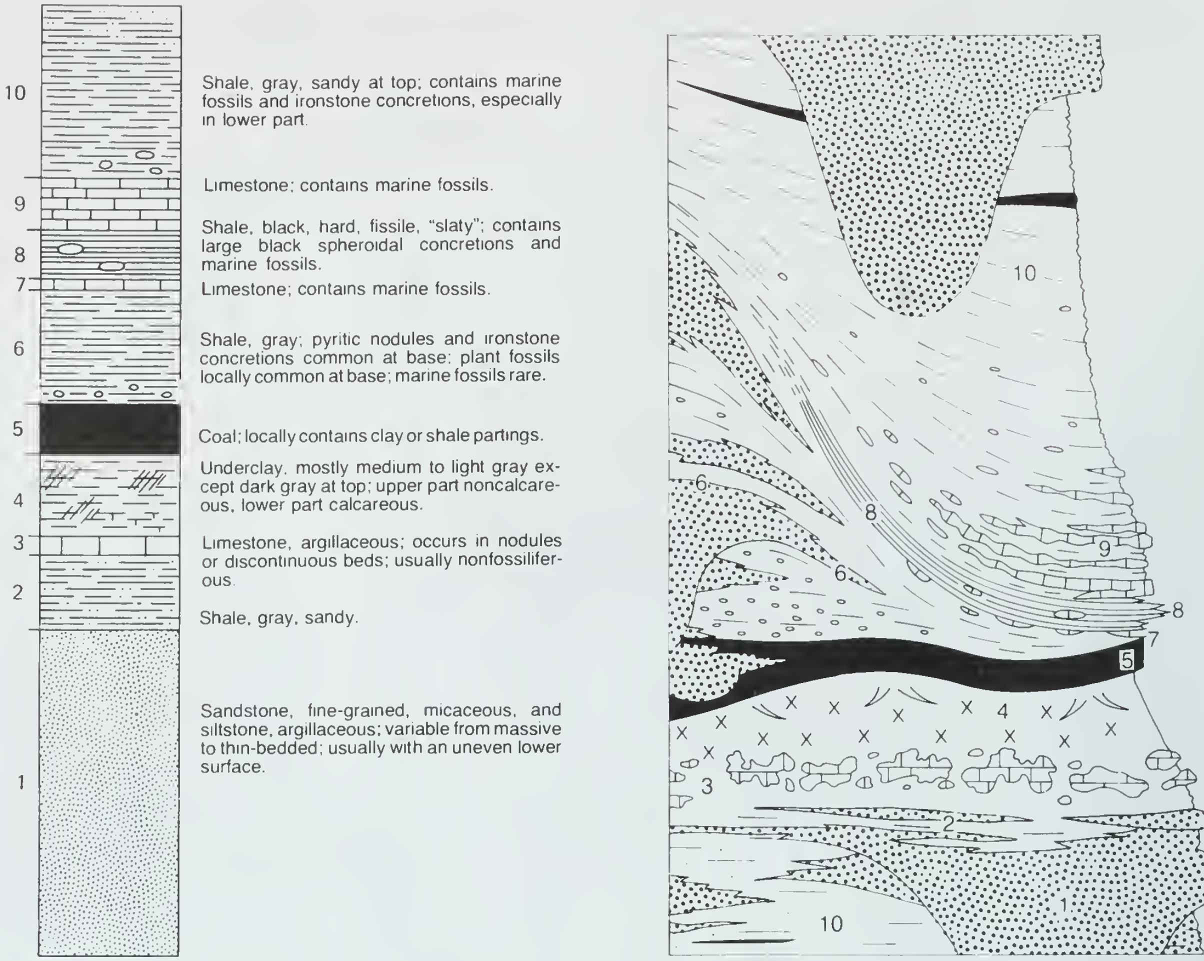

Paleogeography of Illinois-Indiana region during Pennsylvanian time. The diagram shows a Pennsylvanian river delta and the position of the shoreline and the sea at an instant of time during the Pennsylvanian Period.

### Pennsylvanian Cyclothems

The Pennsylvanian strata exhibit extraordinary variations in thickness and composition both laterally and vertically because of the extremely varied environmental conditions under which they formed. Individual sedimentary units are often only a few inches thick and rarely exceed 30 feet thick. Sandstones and shales commonly grade laterally into each other, and shales sometimes interfinger and grade into limestones and coals. The underclays, coals, black shales, and some limestones, however, display remarkable lateral continuity for such thin units. Coal seams have been traced in mines, outcrops, and subsurface drill records over areas comprising several states.



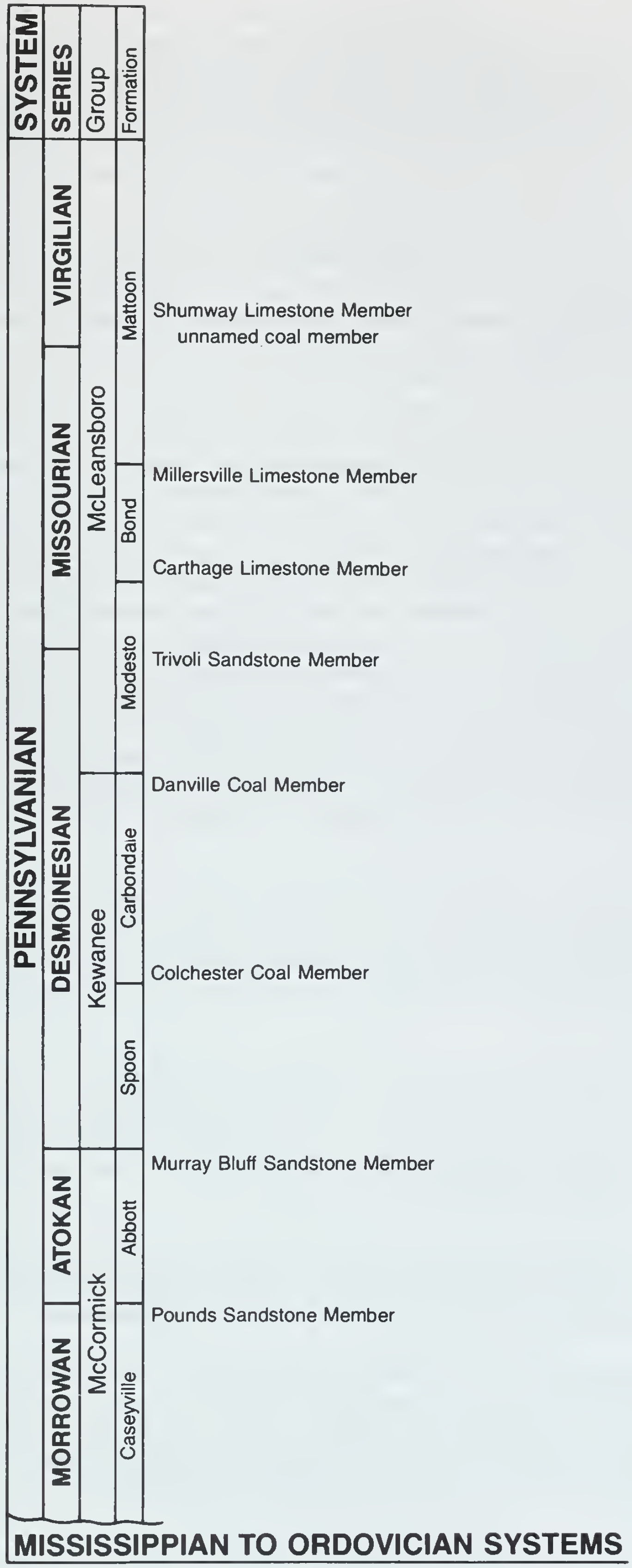

General distribution of the four principal lithologies in Pennsylvanian strata of Illinois.




The idealized cyclothem at left (after Willman and Payne, 1942) infers continuous, widespread distribution of individual cyclothem units, at right the model of a typical cyclothem (after Baird and Shabica, 1980) shows the discontinuous nature of many units in a cyclothem.

The rapid and frequent changes in depositional environments during Pennsylvanian time produced regular or cyclical alternations of sandstone, shale, limestone, and coal in response to the shifting shoreline. Each series of alternations, called a cyclothem, consists of several marine and nonmarine rock units that record a complete cycle of marine invasion and retreat. Geologists have determined, after extensive studies of the Pennsylvanian strata in the Midwest, that an "ideally" complete cyclothem consists of ten sedimentary units (see illustration above contrasting the model of an "ideal" cyclothem with a model showing the dynamic relationships between the various members of a typical cyclothem).

Approximately 50 cyclothems have been described in the Illinois Basin but only a few contain all ten units at any given location. Usually one or more are missing because conditions of deposition were more varied than indicated by the "ideal" cyclothem. However, the order of units in each cyclothem is almost always the same: a typical cyclothem includes a basal sandstone overlain by an underclay, coal, black sheety shale, marine limestone, and gray marine shale. In general, the sandstone-underclay-coal-gray shale portion (the lower six units) of each cyclothem is nonmarine: it was deposited as part of the coastal lowlands from which the sea had withdrawn. However, some of the sandstones are entirely or partly marine. The units above the coal and gray shale are marine sediments deposited when the sea advanced over the coastal plain.




Generalized stratigraphic column of the Pennsylvanian in Illinois (1 inch = approximately 250 feet).

## Origin of Coal

It is generally accepted that the Pennsylvanian coals originated by the accumulation of vegetable matter, usually in place, beneath the waters of extensive, shallow, fresh-to-brackish swamps. They represent the last-formed deposits of the nonmarine portions of the cyclothems. The swamps occupied vast areas of the coastal lowland, which bordered the shallow Pennsylvanian sea. A luxuriant growth of forest plants, many quite different from the plants of today, flourished in the warm, humid Pennsylvanian climate. (Illinois at that time was near the equator.) The deciduous trees and flowering plants that are common today had not yet evolved. Instead, the jungle-like forests were dominated by giant ancestors of present-day club mosses, horsetails, ferns, conifers, and cycads. The undergrowth also was well developed, consisting of many ferns, fernlike plants, and small club mosses. Most of the plant fossils found in the coals and associated sedimentary rocks show no annual growth rings, suggesting rapid growth rates and lack of seasonal variations in the climate (tropical). Many of the Pennsylvanian plants, such as the seed ferns, eventually became extinct.

Plant debris from the rapidly growing swamp forests — leaves, twigs, branches, and logs — accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation, forming water, nitrogen, and carbon dioxide. However, the cover of swamp water, which was probably stagnant and low in oxygen, prevented oxidation, and any decay of the peat deposits was due primarily to bacterial action.

The periodic invasions of the Pennsylvanian sea across the coastal swamps killed the Pennsylvanian forests, and the peat deposits were often buried by marine sediments. After the marine transgressions, peat usually became saturated with sea water containing sulfates and other dissolved minerals. Even the marine sediments being deposited on the top of the drowned peat contained various minerals in solution, including sulfur, which further infiltrated the peat. As a result, the peat developed into a coal that is high in sulfur. However, in a number of areas, nonmarine muds, silts, and sands from the river system on the coastal plain covered the peat where flooding broke through levees or the river changed its coarse. Where these sediments (unit 6 of the cyclothem) are more than 20 feet thick, we find that the coal is low in sulfur, whereas coal found directly beneath marine rocks is high in sulfur. Although the seas did cover the areas where these nonmarine, fluvial sediments covered the peat, the peat was protected from sulfur infiltration by the shielding effect of these thick fluvial sediments.

Following burial, the peat deposits were gradually transformed into coal by slow physical and chemical changes in which pressure (compaction by the enormous weight of overlying sedimentary layers), heat (also due to deep burial), and time were the most important factors. Water and volatile substances (nitrogen, hydrogen, and oxygen) were slowly driven off during the coal-forming ("coalification") process, and the peat deposits were changed into coal.

Coals have been classified by ranks that are based on the degree of coalification. The commonly recognized coals, in order of increasing rank, are (1) brown coal or lignite, (2) sub-bituminous, (3) bituminous, (4) semibituminous, (5) semianthracite, and (6) anthracite. Each increase in rank is characterized by larger amounts of fixed carbon and smaller amounts of oxygen and other volatiles. Hardness of coal also increases with increasing rank. All Illinois coals are classified as bituminous.

Underclays occur beneath most of the coals in Illinois. Because underclays are generally unstratified (unlayered), are leached to a bleached appearance, and generally contain plant roots, many geologists consider that they represent the ancient soils on which the coal-forming plants grew.

The exact origin of the carbonaceous black shale that occurs above many coals is uncertain. Current thinking suggests that the black shale actually represents the deepest part of the marine transgression. Maximum transgression of the sea, coupled with upwelling of ocean water and accumulation of mud and animal remains on an anaerobic ocean floor, led to the deposition of black organic mud over vast areas stretching from Texas to Illinois. Deposition occurred in quiet-water areas where the very fine-grained iron-rich

mud and finely divided plant debris were washed in from the land. Most of the fossils found in black shale represent planktonic (floating) and nektonic (swimming) forms — not benthonic (bottom-dwelling) forms. The depauperate (dwarf) fossil forms sometimes found in black shale formerly were thought to have been forms that were stunted by toxic conditions in the sulfide-rich, oxygen-deficient water of the lagoons. However, study has shown that the "depauperate" fauna consists mostly of normal-size individuals of species that never grew any larger.

## References


Baird, G. C., and C. W. Shabica, 1980, The Mazon Creek depositional event; examination of Francis Creek and analogous facies in the Midcontinent region: *in* Middle and late Pennsylvanian strata on margin of Illinois Basin, Vermilion County, Illinois, Vermilion and Parke counties, Indiana (R. L. Langenheim, editor). Annual Field Conference — Society of Economic Paleontologists and Mineralogists. Great Lakes Section, No. 10, p. 79-92.

Heckel, P. H., 1977, Origin of phosphatic black shale facies in Pennsylvanian cyclothems of mid-continent North America: American Association of Petroleum Geologist Bulletin, v. 61, p. 1045-1068.

Kosanke, R. M., J. A. Simon, H. R. Wanless, and H. B. Willman, 1960, Classification of the Pennsylvanian strata of Illinois: Illinois State Geological Survey Report of Investigation 214, 84 p.

Simon, J. A., and M. E. Hopkins, 1973, Geology of Coal: Illinois State Geological Survey Reprint 1973-H, 28 p.

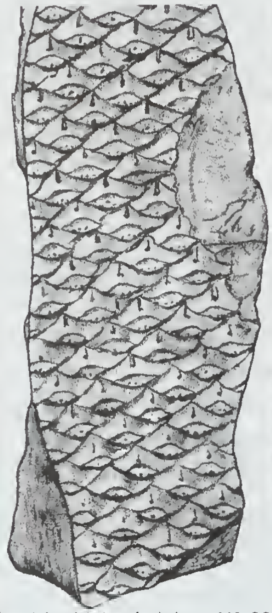
Willman, H. B., and J. N. Payne, 1942, Geology and mineral resources of the Marseilles, Ottawa, and Streator Quadrangles: Illinois State Geological Survey Bulletin 66, 388 p.

Willman, H. B., et al., 1967, Geologic Map of Illinois: Illinois State Geological Survey map; scale, 1:500,000 (about 8 miles per inch).

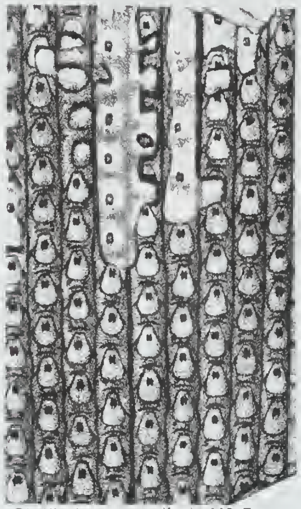
Willman, H. B., E. Atherton, T. C. Buschbach, C. W. Collinson, J. C. Frye, M. E. Hopkins, J. A. Lineback, and J. A. Simon, 1975, Handbook of Illinois Stratigraphy: Illinois State Geological Survey Bulletin 95, 261 p.

# Common Pennsylvanian plants: lycopods, sphenophytes, and ferns

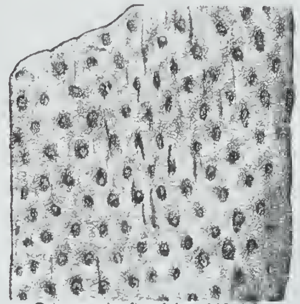
*Lepidodendron aculeatum* X0.8



*Lepidophloios laricinus* X0.63

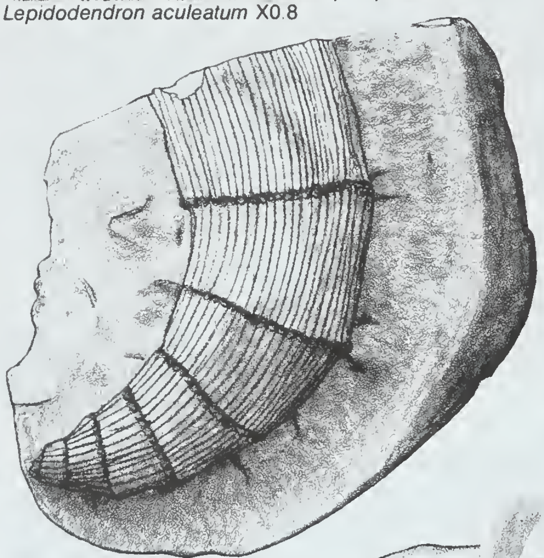


*Sigillaria mammilaris* X0.5



*Stigmaria ficoides* X0.32

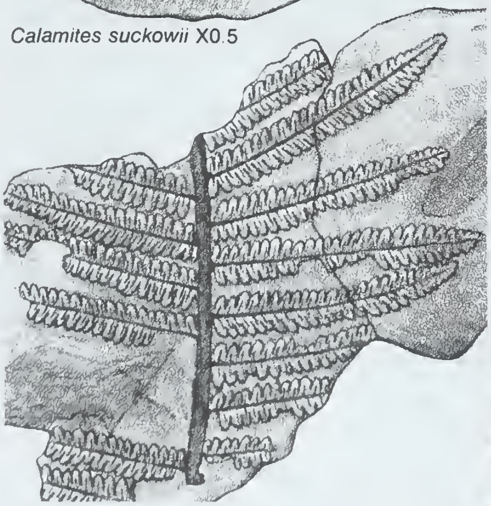
*Lepidostrobus ovatifolius* X0.8



*Calamites suckowii* X0.5

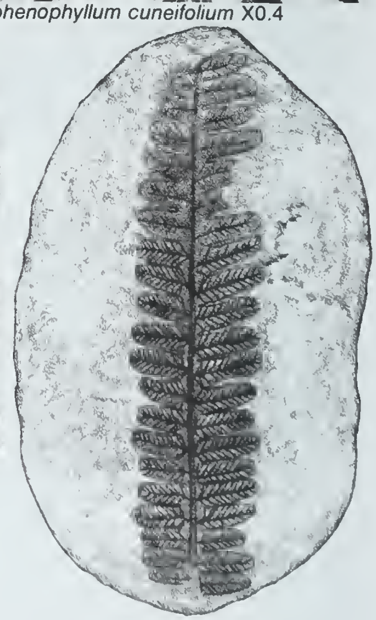
*Annularia stellata* X0.63

*Sphenophyllum cuneifolium* X0.4



*Pecopteris* sp. X0.32

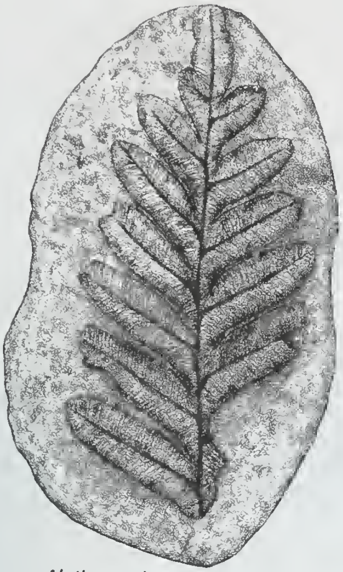
*Pecopteris miltonii* X2.0



*Pecopteris hemitelioides* X1.0

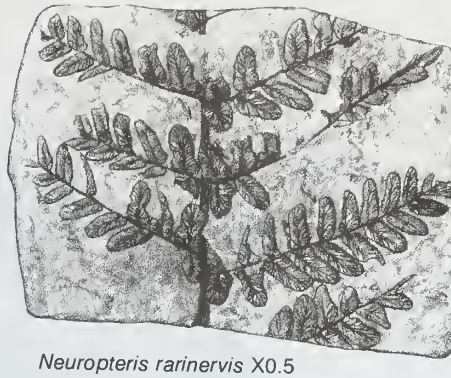
J. R. Jennings, ISGS

## Common Pennsylvanian plants: seed ferns and cordaiteans



*Alethopteris serlii* X0.63

*Alethopteris ambigua* X0.63



*Neuropteris rarinervis* X0.5

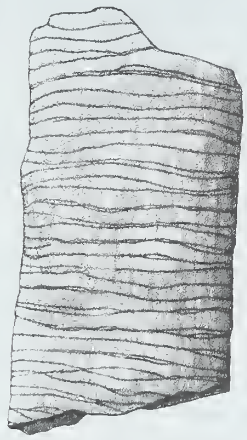
*Mariopteris nervosa* X0.8

*Neuropteris scheuchzeri* X0.63

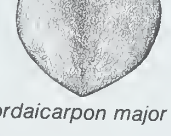
*Sphenopteris rotundiloba* X0.8

*Trigonocarpus parkinsonii* X1.25

*Cordaicladus* sp. X1.0



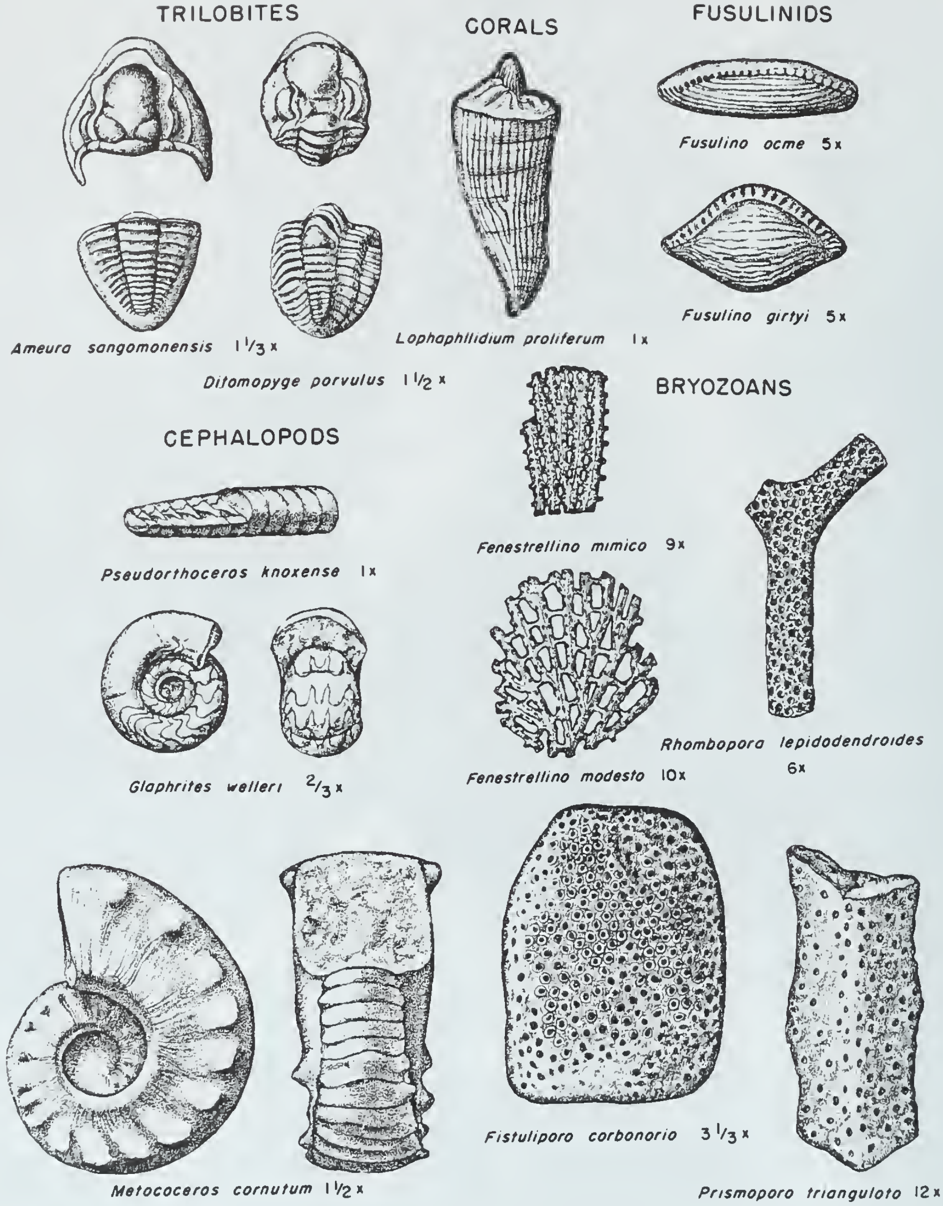
*Artisia transversa* X0.63

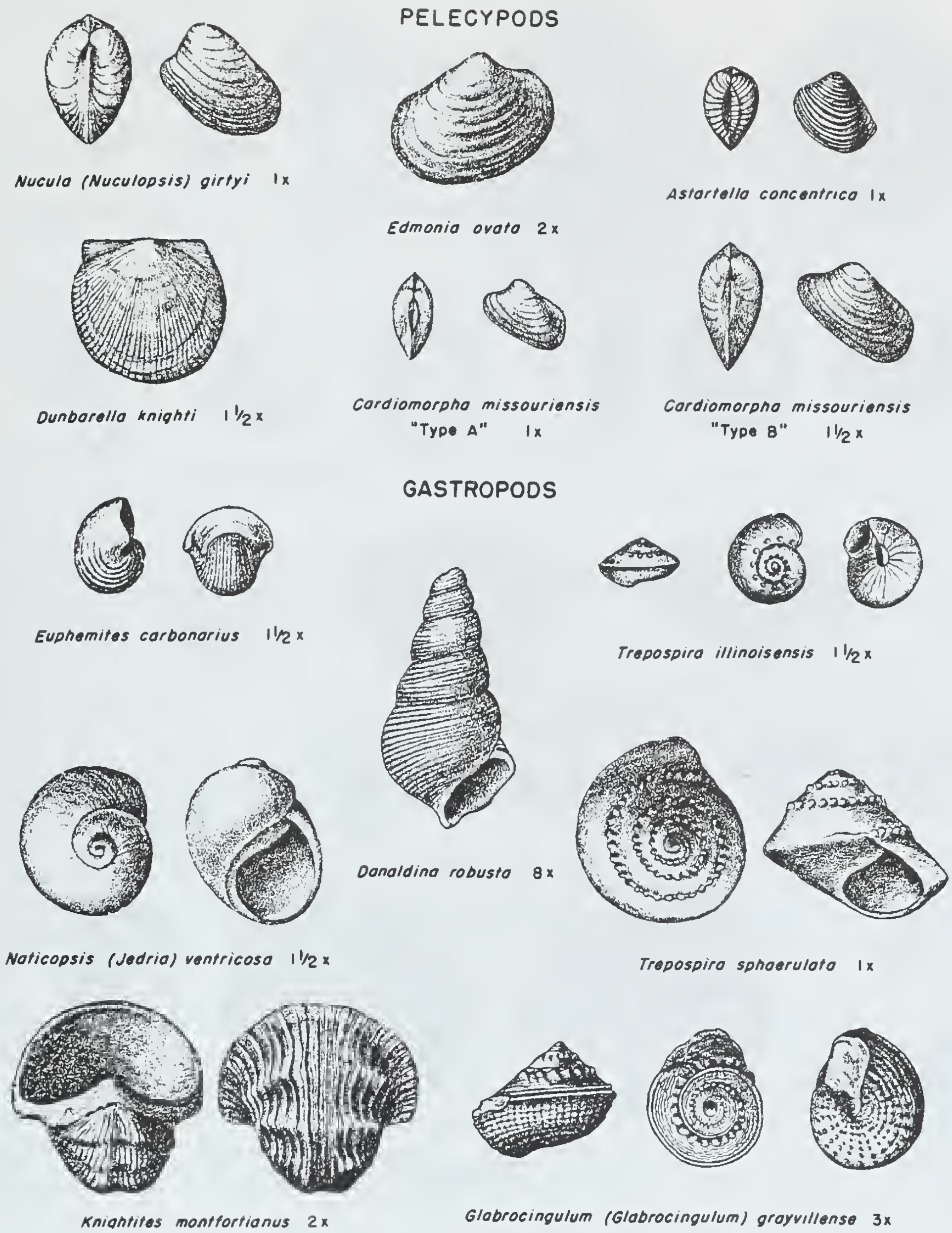


*Cordaicarpon major* X2.0

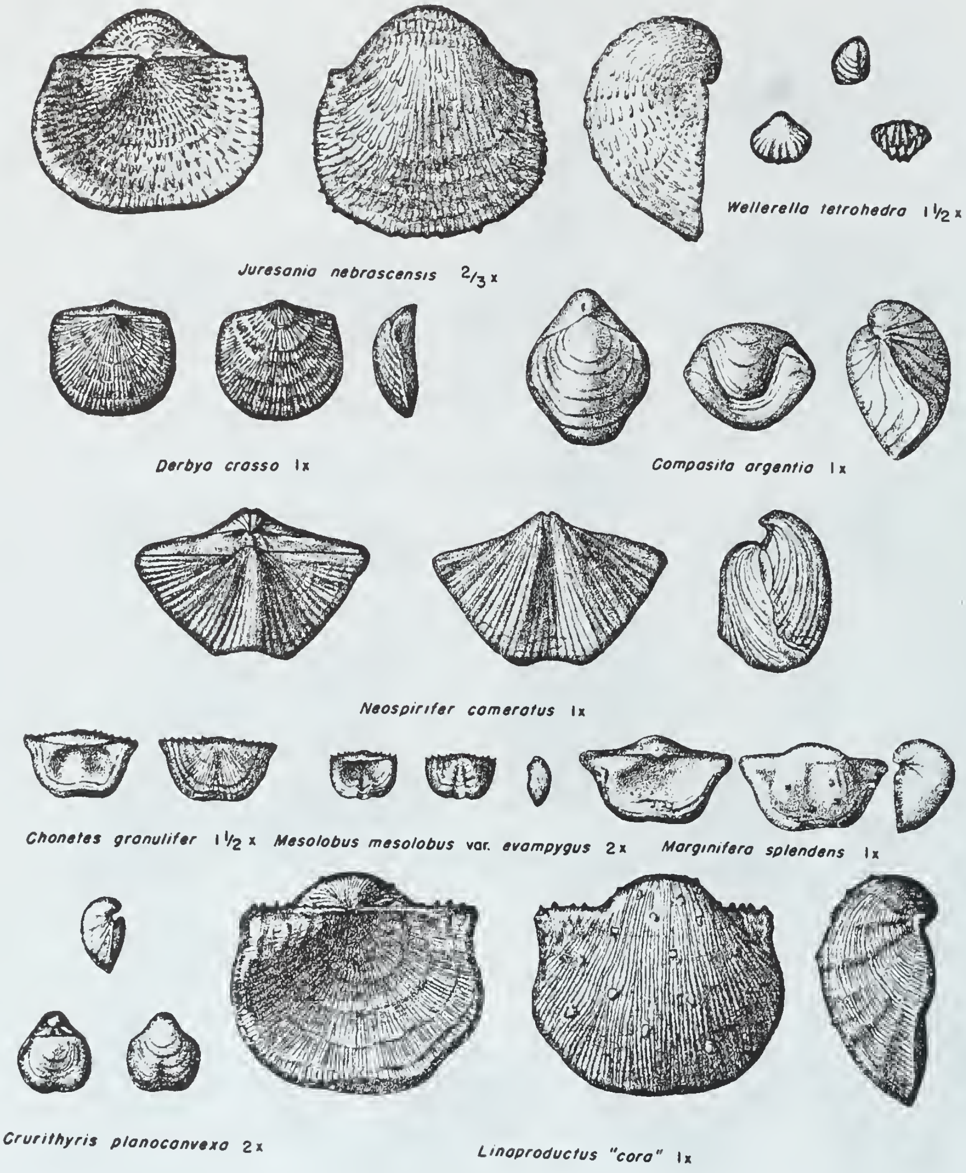
*Cordaites principalis* X0.63

J. R. Jennings, ISGS


TRILOBITES
CORALS
FUSULINIDS
Fusulina acme 5x
Fusulina girtyi 5x
Ameura sangamonensis $1\frac{1}{3}$x
Lophophyllidium proliferum 1x
Ditomopyge parvulus $1\frac{1}{2}$x
BRYOZOANS
CEPHALOPODS
Pseudorthoceras knoxense 1x
Fenestrellina mimica 9x
Rhombopora lepidodendroides 6x
Glaphrites welleri $\frac{2}{3}$x
Fenestrellina modesta 10x
Fistulipora carbonaria $3\frac{1}{3}$x
Metacoceras cornutum $1\frac{1}{2}$x
Prismopora triangulata 12x


PELECYPODS
Nucula (Nuculopsis) girtyi 1x
Edmonia ovata 2x
Astartella concentrica 1x
Dunbarella knighti 1½x
Cardiomorpha missouriensis "Type A" 1x
Cardiomorpha missouriensis "Type B" 1½x
GASTROPODS
Euphemites carbonarius 1½x
Trepospira illinoisensis 1½x
Donaldina robusta 8x
Naticopsis (Jedria) ventricosa 1½x
Trepospira sphaerulata 1x
Knightites montfortianus 2x
Glabrocingulum (Glabrocingulum) grayvillense 3x

# BRACHIOPODS



# MISSISSIPPIAN ROCKS IN ILLINOIS

**Janis D. Treworgy**

## AGE AND DISTRIBUTION

The Mississippian Period is the interval of earth's geologic history that lasted from about 360 to 320 million years ago (fig. 1). The term *Mississippian System* refers to the layers of sediment that were deposited during this period. Today, Mississippian-age rocks are present in the southern two-thirds of Illinois where they are over 3,200 feet thick (fig. 2). These rocks were more widely distributed over the midcontinent but were removed in places by erosion. Although these layers of rock were originally horizontal deposits, they were warped downward into the shape of a shallow basin because of stresses in the earth's crust. This large downwarped depression is called the Illinois Basin. At the deepest part of the basin in southeastern Illinois, the Mississippian rocks are as deep as 5,000 feet. In western and southernmost Illinois, Mississippian rocks are shallow and exposed at the surface around the edge of the the basin (see outcrop areas in fig. 2).

## ECONOMIC SIGNIFICANCE

Mississippian rock resources have been important to the mineral industries and economy of Illinois since the early 1800s.

- Nearly 80% of the oil produced in Illinois has been pumped from Mississippian rocks (Howard 1991). This crude oil is refined to produce gasoline, fuel oil, asphalt, road oil, lubricants, and other petroleum products, including petrochemicals.

- Fluorite (fluorspar), sphalerite (zinc ore), and galena (lead ore) were mined from major mineral deposits in heavily faulted Mississippian rocks in Hardin and Pope Counties, southernmost Illinois, from the early 1800s until the last mine closed in 1995. Mining ceased because of cheaper sources from other countries, primarily China and Mexico. Additional research on the Mississippian rocks in southernmost Illinois may lead to the discovery of new economically minable fluorite or other mineral deposits.

  Fluorite (calcium fluoride), Illinois' state mineral, is used in a variety of manufacturing processes, for example, as a flux in refining iron ore to steel. Fluorite is primarily used to make hydrogen fluoride (hydrofluoric acid) and fluorine gas, an ingredient in making refrigerants, solvents, lubricants, and toothpaste.

- About one-third of the limestone and dolomite for crushed stone in Illinois is quarried from Mississippian rocks. Crushed stone, also called construction aggregate, is used for road construction, concrete structures, agricultural lime, sulfur-dioxide removal from coal-burning power plant flues, and production of Portland cement and various chemicals. Some Mississippian-age limestone was quarried as a building and decorative stone in southern Illinois until the 1960s. It is similar to the "Indiana Limestone," a building stone used nationwide that is quarried in south-central Indiana.

## PALEOGEOGRAPHY

**Continental plate movement** *Paleogeography* means "ancient" geography. During the Mississippian, the area now called Illinois was located south of the equator (fig. 3). The equator has not moved during the history of the earth, but the "plates" that make up the earth's crust have slowly moved around during earth's life of 4.6 billion years. During the 40 million years of the Mississippian Period, what is now Illinois moved slowly northward from near 30° south latitude to just north of 10° south latitude. About 100 million years later, all the continental plates drifted together and formed the supercontinent Pangea. Since then, the continental plates have been slowly drifting apart.

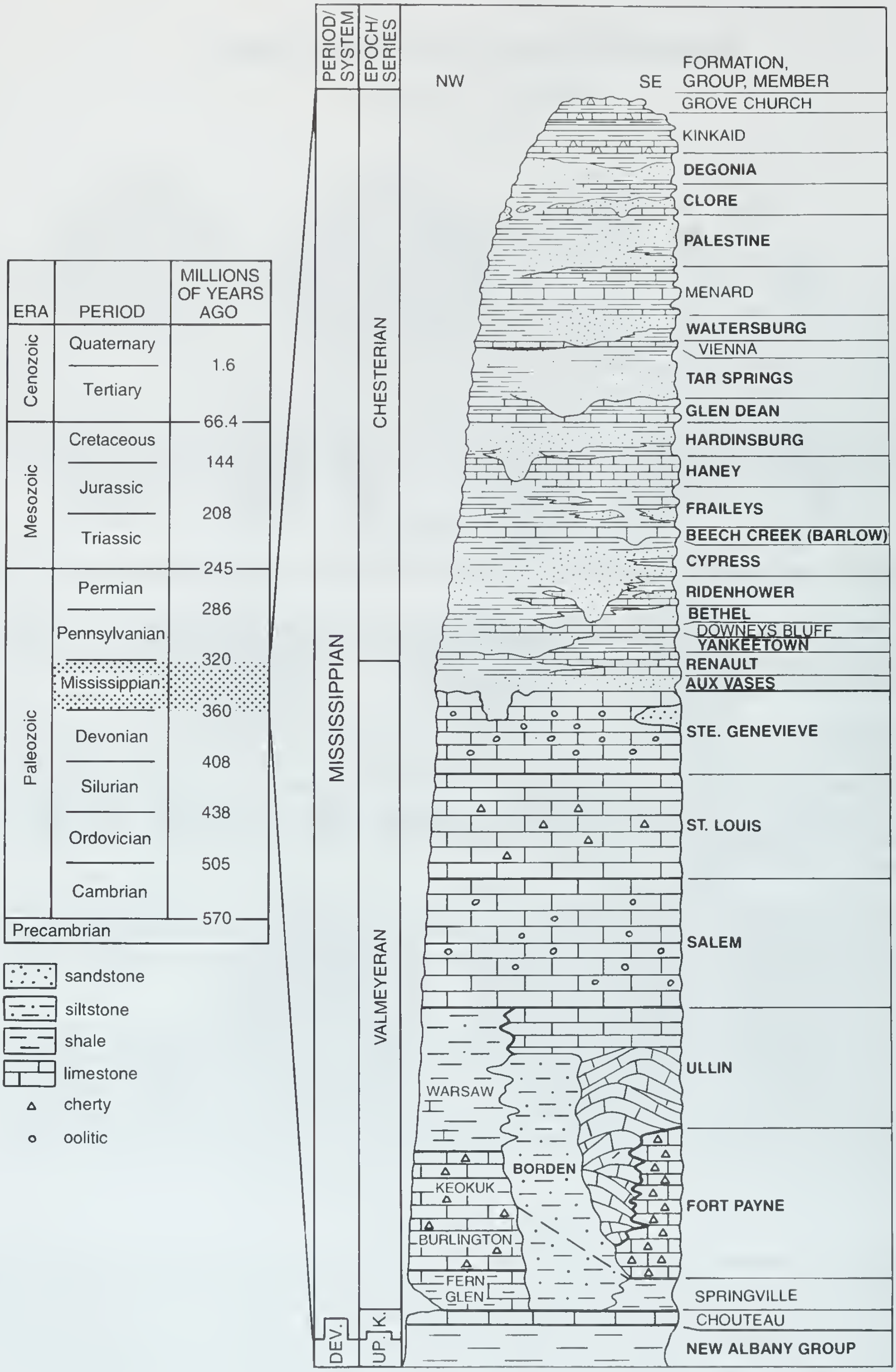



**Figure 1** Mississippian rock units in Illinois. Units that have produced oil are shown in bold type. The base of the Fort Payne is approximately equivalent in time to the base of the Keokuk (dashed line). DEV = Devonian, UP = Upper Devonian, and K = Kinderhookian.

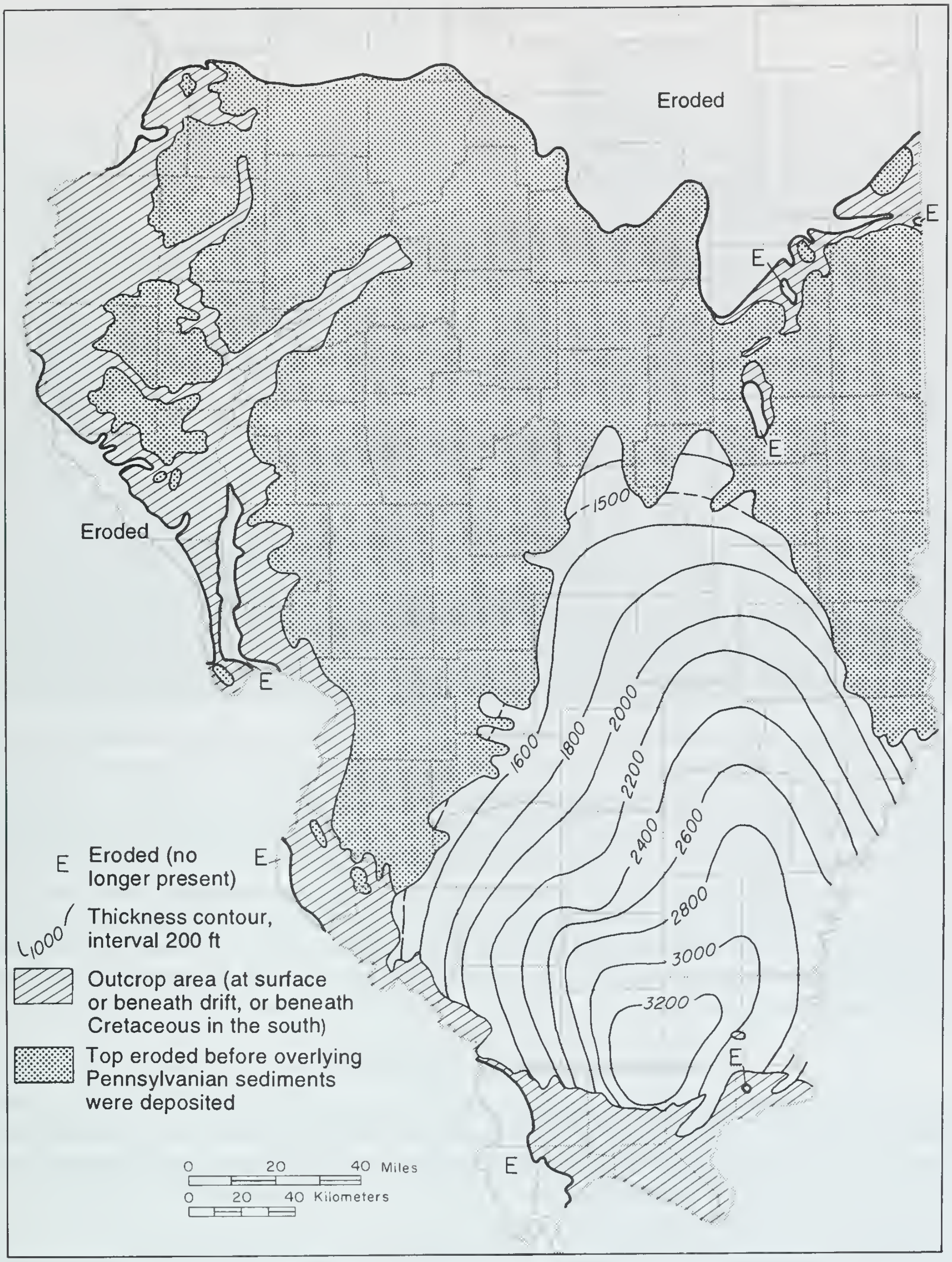



**Figure 2** Distribution and thickness of the Mississippian rocks in Illinois. Thickness contours are shown where upper Chesterian rocks are present (modified from Atherton et al. 1975).

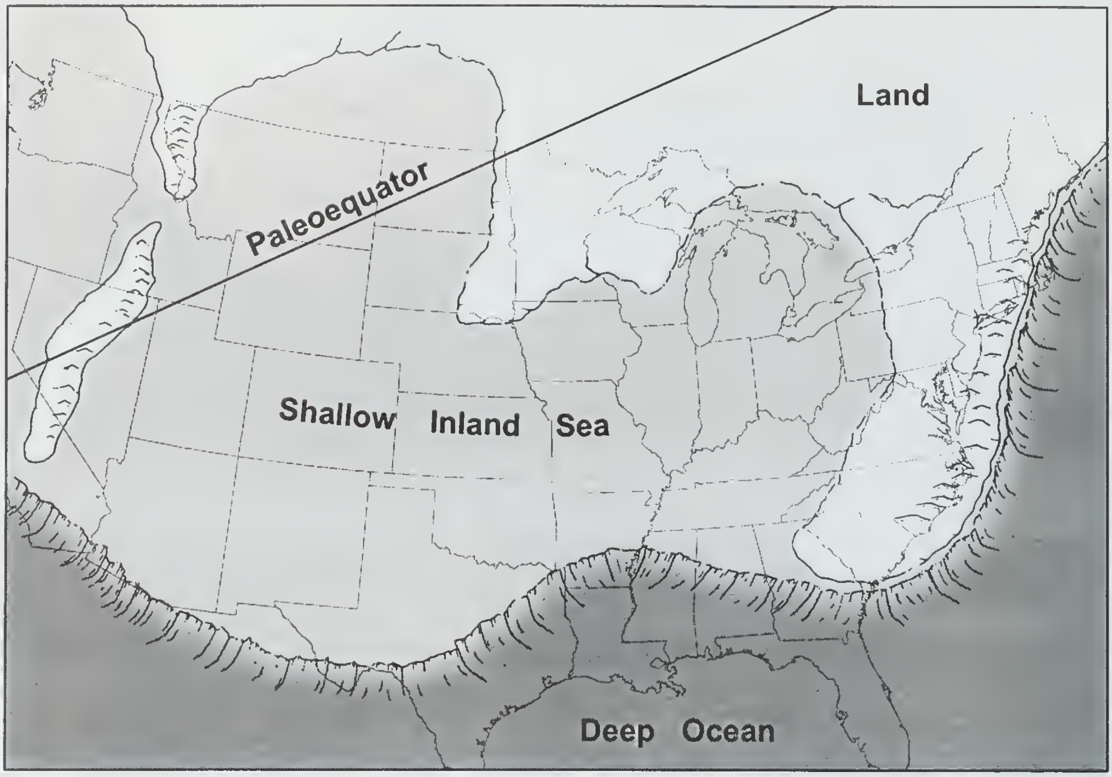



**Figure 3** Position of much of the United States and general paleogeography during the Mississippian Period, approximately 350 million years ago.

**Ancient seas** Illinois and surrounding areas of the midcontinent were covered by a warm, shallow inland sea that extended inland from the deep ocean at the edge of the continental plate (fig. 3). During the early part of the Mississippian, this inland sea covered most of the midcontinent and was up to several hundred feet deep in the southern Illinois area. During the later part of the Mississippian, sea level dropped and exposed more land. As a result, the sea became shallower, just a few tens of feet deep in the Illinois Basin. Geologists can tell relative water depths from the type of sea life preserved as fossils in the rocks (plates A and B) and from sedimentary patterns or structures, such as ripple marks, that were formed in the sediment by currents generated by tides and waves.

## COMMON MISSISSIPPIAN ROCKS

Common rocks of Mississippian age found in the Illinois area formed at the bottom of the shallow inland sea. Rivers and streams eroded sand, silt, and clay from the surrounding land and carried them into the sea where they were deposited on the bottom. *Shale* forms when mud (a mixture of fine clay and silt) collects at the bottom of the sea and is buried and compacted (lithified, or made rock-like). *Sandstone* and *siltstone* form similarly, but from coarser sand and silt particles.

*Limestone*, the most abundant Mississippian rock type in Illinois, formed differently. Limestone is primarily calcium carbonate (calcite, or $CaCO_3$) and can form in several ways. One of the most common ways begins with sea animals (such as crinoids, brachiopods, bryozoans, and molluscs) that secrete calcium carbonate to form their protective shells. When these animals die, their shells collect on the sea floor. Often the shells are broken by strong currents (due to storms and tides) near shore and carried seaward. When these shells become compacted and cemented on the sea floor (by calcite that precipitates from the sea water), limestone forms. Calcite-secreting animals are most abundant and prolific in clear, warm, relatively shallow water where there is little mud coming into the sea. Because these animals feed by filtering tiny floating plants and animals from the sea water, mud would choke them. Some limestones (for example, oolitic limestone) are a chemical precipitate from the sea water. Others (for example, micrite) form in part through precipitation caused

by microbes, algae, or other organisms. In some cases, limestone is recrystallized to form a magnesium-rich carbonate rock called *dolostone* (or *dolomite*).

## DEPOSITIONAL HISTORY

Various combinations of the rocks described above were deposited in Illinois during the 40 million years of the Mississippian Period. The oldest rocks were laid down first and are at the bottom of the sequence (fig. 1).

**Pre-Mississippian** Before Mississippian times, late in the Devonian Period (fig. 1), mud was being deposited in the sea that covered the area. This mud continued to enter the sea during the early Mississippian Period (Kinderhookian Epoch). As the mud was buried and compacted, it became shale. The sea during this time ranged from a few tens of feet deep near the shore to several hundred feet deep in southeastern Illinois, where the shale is thickest. Geologists call this shale unit the New Albany Group (fig.1). Today this shale is at the surface in western Illinois but is more than 5,000 feet deep in southeastern Illinois, where it is 450 feet thick.

This shale is rich in organic matter that was mostly derived from dead marine plants and animals that accumulated on the ancient sea floor. As the shale was buried progressively deeper in the earth's crust by overlying sediments, it became warmer. (The earth is hotter toward the center.) Eventually, about 250 to 150 million years ago, the shale became so hot (at least 125°F) that the organic matter "cooked" and released oil and gas. This oil and gas moved slowly upward along fractures and through pore spaces into and through overlying rock units. Some of this oil and gas became "trapped" in porous rock that is overlain by very dense rock. It is this trapped oil and gas that some geologists look for and that is pumped from the ground for our use.

**Kinderhookian Epoch** The amount of mud carried into the sea eventually diminished and allowed sea animals to dominate long enough for a thin limestone, the Chouteau Limestone, to be deposited over much of the southern half of Illinois. This limestone marked the end of the Kinderhookian Epoch (fig. 1).

**Valmeyeran Epoch** During Valmeyeran time (fig. 1), the sea continued to cover much of the midcontinent (fig. 3). In western Illinois, where the sea was now clear and shallow, more than 150 feet of limestone (Fern Glen, Burlington, and Keokuk Limestones, fig. 1) formed a bank with a fairly sharp eastern slope that dropped off into deeper water. Initially, while this limestone was forming in western Illinois, very little sediment (Springville Shale) was being deposited in the southeastern part of the state, where the sea was much deeper.

Later, silt, clay, and sand again entered the sea from the east and northeast, forming the rock unit called the Borden Siltstone (fig. 1). This clay and silt eventually spread into western Illinois and choked most of the calcite-secreting organisms, thereby ending limestone production. Where the shales and siltstones that developed from this clay and silt overlie the limestone in the west, geologists call them the Warsaw Shale (fig. 1). The Warsaw, well known for its geodes, is exposed at the surface in parts of western Illinois. The shales and siltstones of the Borden are present in central and southern Illinois and reach a maximum thickness of 700 feet thick in east-central Illinois.

While deposits of the Borden Siltstone were still accumulating along the center of what is now Illinois, limestone began to form again to the east and south. Initially, the Fort Payne Formation (fig. 1) was deposited in relatively deep water. Then, as the amount of silt and clay entering the area gradually diminished, the Ullin, Salem, St. Louis, and Ste. Genevieve Limestones (fig. 1) formed in the warm, clear, and progressively shallower water.

Today, these Valmeyeran-age limestones are up to 1,800 feet thick in southeastern Illinois where they are buried as deep as 5,000 feet. The limestones are present at the surface in western Illinois, most notably in the bluffs along the Mississippi River between Alton and Grafton, and in southern Illinois. Where shallow enough, the limestones are quarried in parts of southern and western Illinois. Oil is produced from some of the limestones in southeastern Illinois; about 18% of all Illinois oil production comes from porous zones in the Ste. Genevieve Limestone (Howard 1991). The deeper limestones can be as productive as the Ste. Genevieve, but they have not been fully explored.

**Chesterian Epoch** Near the end of Valmeyeran time, relative sea level gradually dropped, and the northern shoreline moved southward and exposed more land. This transition marked the end of the Valmeyeran Epoch and the beginning of the Chesterian Epoch (fig. 1). As sea level lowered, more mud and

sand were carried by ancient rivers and streams from land areas to the north, northeast, and northwest into the sea in the Illinois area. The mud and sand carried into the sea were reworked by tidal currents and distributed over large areas of the sea floor, where they were buried and eventually formed shale and sandstone. Shell-forming organisms were relatively less common during Chesterian time because they were choked by this mud and sand in the water. Periodically during the Chesterian, the sea withdrew entirely from the area of Illinois for a time and then returned. Paleosols (ancient soils) and deeply eroded valleys that have since been filled with sediment are evidence of these periods of dry or exposed land.

Periodically, sea level rose, and the quantities of mud and sand flowing into the sea were reduced. During these times, shell-forming organisms prospered once again, and thin limestones formed in this inland sea. These limestones are commonly only 10 to 30 feet thick, unlike the thicker ones of Valmeyeran age.

These fluctuations in sea level during the Chesterian resulted in deposition of alternating units of shale, sandstone, and limestone, which geologists refer to as cyclic sedimentation.

Chesterian rocks are present in the southern half of Illinois. Although the rocks are at the land surface in parts of southwestern and southernmost Illinois, in southeastern Illinois they are as deep as 3,000 feet. They are as thick as 1,400 feet in southernmost Illinois. Sandstones of Chesterian age have produced about 60% of the oil found in Illinois (Howard 1991).

The Chesterian, the last epoch of the Mississippian Period, was a time of transition from the Valmeyeran Epoch, when the seas were clear and thick limestones formed, to the subsequent Pennsylvanian Period, when the seas shallowed and disappeared for longer periods of time, and shale, siltstone, sandstone, and coal were the major deposits formed.

## REFERENCES

Atherton, E., C. Collinson, and J.A. Lineback, 1975, Mississippian System, *in* H.B. Willman et al., Handbook of Illinois Stratigraphy: Illinois State Geological Survey Bulletin 95, p. 123–163.

Howard, R.H., 1991, Hydrocarbon reservoir distribution in the Illinois Basin, *in* M.W. Leighton, D.R. Kolata, D.F. Oltz, and J.J. Eidel, editors, Interior Cratonic Basins: American Association of Petroleum Geologists Memoir 51, p. 299–327.

GeoScience Education Note 1 1997

Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
William W. Shilts, Chief

Natural Resources Building
615 East Peabody Drive
Champaign, IL 61820-6964

(217) 333-4747

*Printed by authority of the State of Illinois/1997/500*
*Printed with soybean ink on recycled paper*

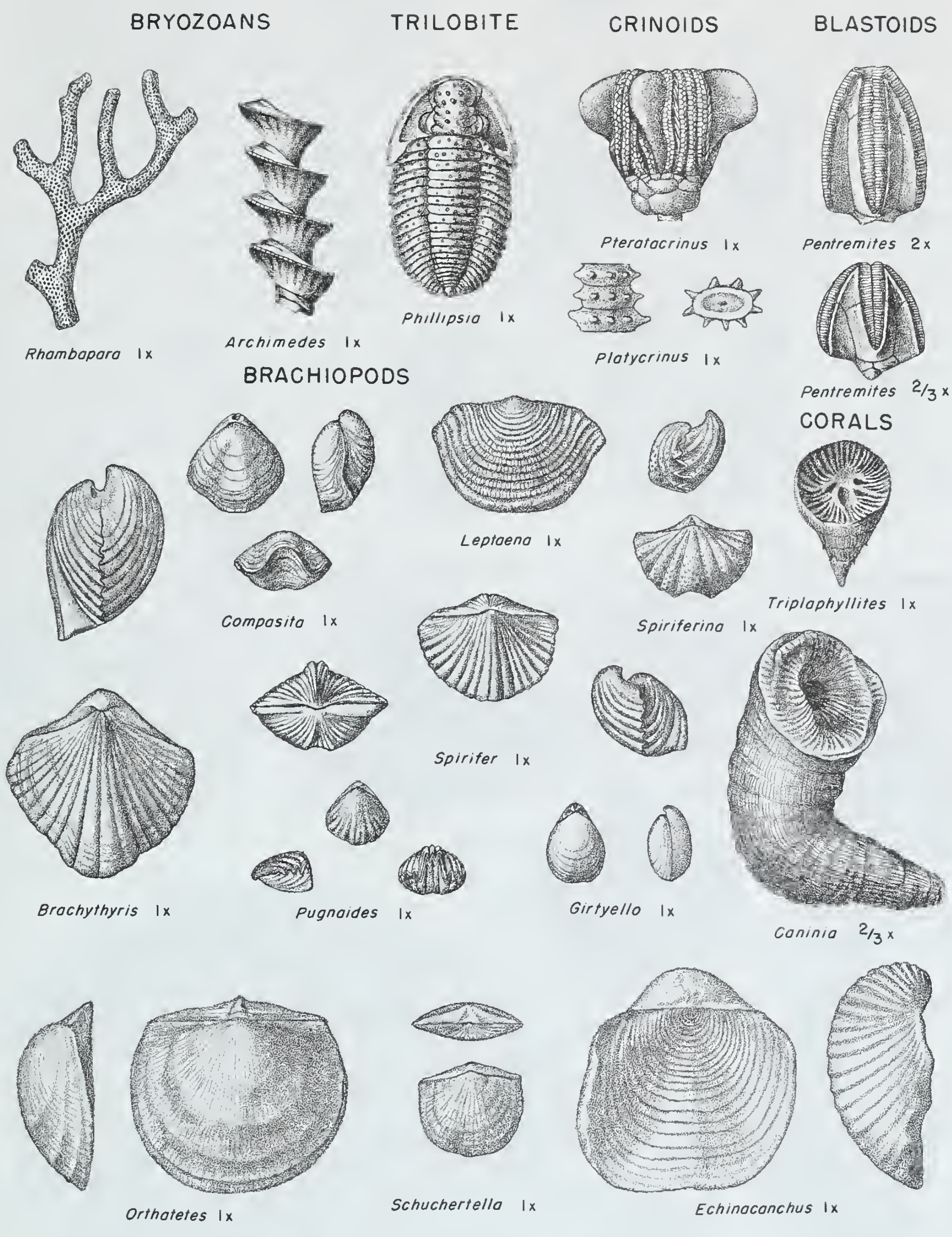



**PLATE A** Typical Mississippian fossils.

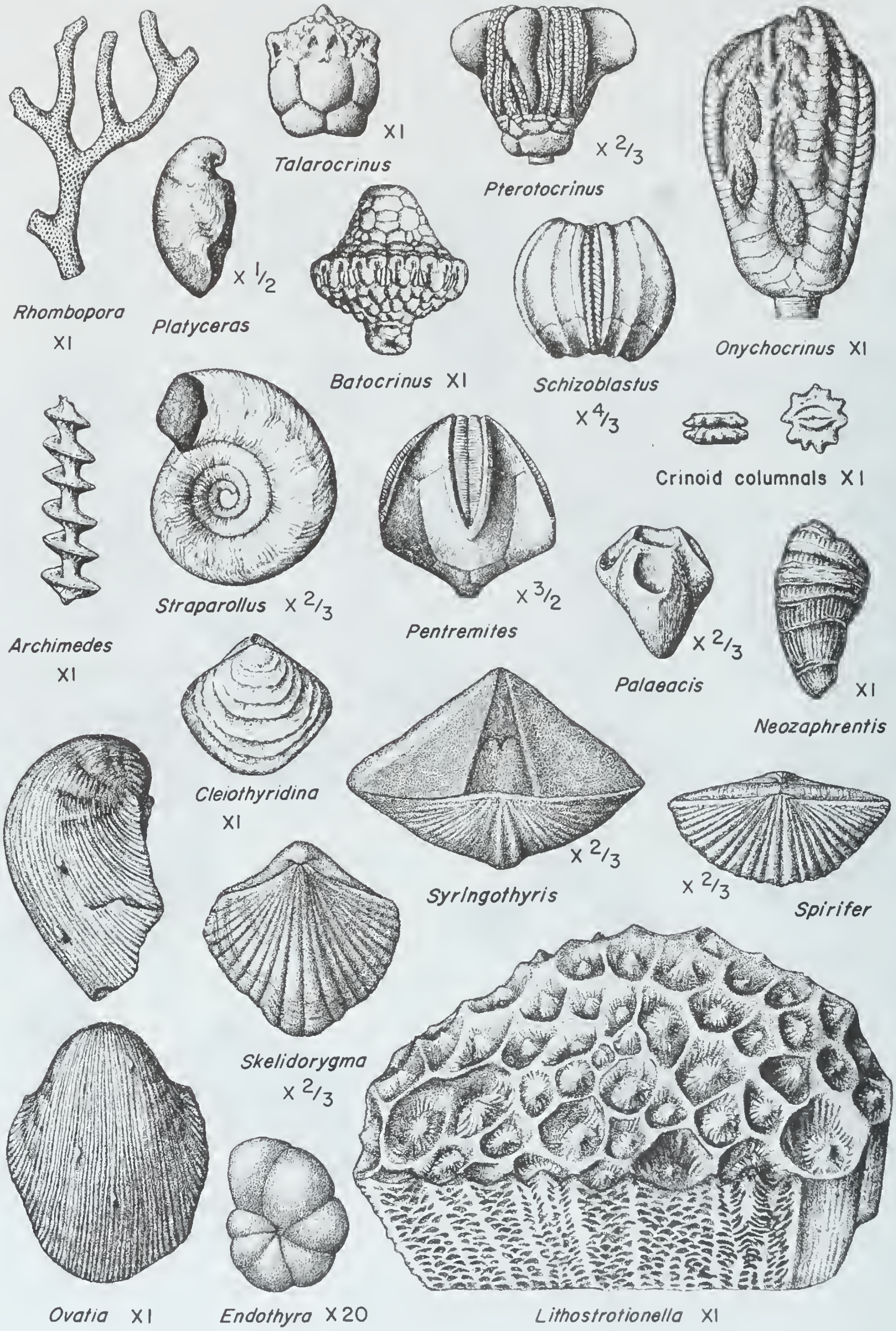



**PLATE B** Typical Mississippian fossils.

# PLEISTOCENE GLACIATIONS IN ILLINOIS

## Origin of the Glaciers

During the past million years or so, an interval of time called the Pleistocene Epoch, most of the northern hemisphere above the 50th parallel has been repeatedly covered by glacial ice. The cooling of the earth's surface, a prerequisite for glaciation, began at least 2 million years ago. On the basis of evidence found in subpolar oceans of the world (temperature-dependent fossils and oxygen-isotope ratios), a recent proposal has been made to recognize the beginning of the Pleistocene at 1.6 million years ago. Ice sheets formed in sub-arctic regions many times and spread outward until they covered the northern parts of Europe and North America. In North America, early studies of the glacial deposits led to the model that four glaciations could explain the observed distribution of glacial deposits. The deposits of a glaciation were separated from each other by the evidence of intervals of time during which soils formed on the land surface. In order of occurrence from the oldest to the youngest, they were given the names Nebraskan, Kansan, Illinoian, and Wisconsinan Stages of the Pleistocene Epoch. Work in the last 30 years has shown that there were more than four glaciations but the actual number and correlations at this time are not known. Estimates that are gaining credibility suggest that there may have been about 14 glaciations in the last one million years. In Illinois, estimates range from 4 to 8 based on buried soils and glacial deposits. For practical purposes, the previous four glacial stage model is functional, but we now know that the older stages are complex and probably contain more than one glaciation. Until we know more, all of the older glacial deposits, including the Nebraskan and Kansan will be classified as pre-Illinoian. The limits and times of the ice movement in Illinois are illustrated in the following pages by several figures.

The North American ice sheets developed when the mean annual temperature was perhaps 4° to 7°C (7° to 13°F) cooler than it is now and winter snows did not completely melt during the summers. Because the time of cooler conditions lasted tens of thousands of years, thick masses of snow and ice accumulated to form glaciers. As the ice thickened, the great weight of the ice and snow caused them to flow outward at their margins, often for hundreds of miles. As the ice sheets expanded, the areas in which snow accumulated probably also increased in extent.

Tongues of ice, called lobes, flowed southward from the Canadian centers near Hudson Bay and converged in the central lowland between the Appalachian and Rocky Mountains. There the glaciers made their farthest advances to the south. The sketch below shows several centers of flow, the general directions of flow from the centers, and the southern extent of glaciation. Because Illinois lies entirely in the central lowland, it has been invaded by glaciers from every center.

## Effects of Glaciation

Pleistocene glaciers and the waters melting from them changed the landscapes they covered. The glaciers scraped and smeared the landforms they overrode, leveling and filling many of the minor valleys and even some of the larger ones. Moving ice carried colossal amounts of rock and earth, for much of what the glaciers wore off the ground was kneaded into the moving ice and carried along, often for hundreds of miles.

The continual floods released by melting ice entrenched new drainageways, deepened old ones, and then partly refilled both with sediments as great quantities of rock and earth were carried beyond the glacier fronts. According to some estimates, the amount of water drawn from the sea and changed into ice during a glaciation was enough to lower the sea level from 300 to 400 feet below present level. Consequently, the melting of a continental ice sheet provided a tremendous volume of water that eroded and transported sediments.

In most of Illinois, then, glacial and meltwater deposits buried the old rock-ribbed, low, hill-and-valley terrain and created the flatter landforms of our prairies. The mantle of soil material and the buried deposits of gravel, sand, and clay left by the glaciers over about 90 percent of the state have been of incalculable value to Illinois residents.

## Glacial Deposits

The deposits of earth and rock materials moved by a glacier and deposited in the area once covered by the glacier are collectively called **drift**. Drift that is ice-laid is called **till**. Water-laid drift is called **outwash**.

Till is deposited when a glacier melts and the rock material it carries is dropped. Because this sediment is not moved much by water, a till is unsorted, containing particles of different sizes and compositions. It is also stratified (unlayered). A till may contain materials ranging in size from microscopic clay particles to large boulders. Most tills in Illinois are pebbly clays with only a few boulders. For descriptive purposes, a mixture of clay, silt, sand and boulders is called **diamicton**. This is a term used to describe a deposit that could be interpreted as till or a mass wasting product.

Tills may be deposited as **end moraines**, the arc-shaped ridges that pile up along the glacier edges where the flowing ice is melting as fast as it moves forward. Till also may be deposited as **ground moraines**, or **till plains**, which are gently undulating sheets deposited when the ice front melts back, or retreats. Deposits of till identify areas once covered by glaciers. Northeastern Illinois has many alternating ridges and plains, which are the succession of end moraines and till plains deposited by the Wisconsinan glacier.

Sorted and stratified sediment deposited by water melting from the glacier is called **outwash**. Outwash is bedded, or layered, because the flow of water that deposited it varied in gradient, volume, velocity, and direction. As a meltwater stream washes the rock materials along, it sorts them by size—the fine sands, silts, and clays are carried farther downstream than the coarser gravels and cobbles. Typical Pleistocene outwash in Illinois is in multilayered beds of clays, silts, sands, and gravels that look much like modern stream deposits in some places. In general, outwash tends to be coarser and less weathered, and alluvium is most often finer than medium sand and contains variable amounts of weathered material.

Outwash deposits are found not only in the area covered by the ice field but sometimes far beyond it. Meltwater streams ran off the top of the glacier, in crevices in the ice, and under the ice. In some places, the cobble-gravel-sand filling of the bed of a stream that flowed in the ice is preserved as a sinuous ridge called an **esker**. Some eskers in Illinois are made up of sandy to silty deposits and contain mass wasted diamicton material. Cone-shaped mounds of coarse outwash, called **kames**, were formed where meltwater plunged through crevasses in the ice or into ponds on the glacier.

The finest outwash sediments, the clays and silts, formed bedded deposits in the ponds and lakes that filled glacier-dammed stream valleys, the sags of the till plains, and some low, moraine-diked till plains. Meltwater streams that entered a lake rapidly lost speed and also quickly dropped the sands and gravels they carried, forming deltas at the edge of the lake. Very fine sand and silts were commonly redistributed on the lake bottom by wind-generated currents, and the clays, which stayed in suspension longest, slowly settled out and accumulated with them.

Along the ice front, meltwater ran off in innumerable shifting and short-lived streams that laid down a broad, flat blanket of outwash that formed an **outwash plain**. Outwash was also carried away from the glacier in valleys cut by floods of meltwater. The Mississippi, Illinois, and Ohio Rivers occupy valleys that were major channels for meltwaters and were greatly widened and deepened during times of the greatest meltwater floods. When the floods waned, these valleys were partly filled with outwash far beyond the ice margins. Such outwash deposits, largely sand and gravel, are known as **valley trains**. Valley train deposits may be both extensive and thick. For instance, the long valley train of the Mississippi Valley is locally as much as 200 feet thick.

## Loess, Eolian Sand and Soils

One of the most widespread sediments resulting from glaciation was carried not by ice or water but by wind. **Loess** is the name given to windblown deposits dominated by silt. Most of the silt was derived from wind erosion of the valley trains. Wind action also sorted out **eolian sand** which commonly formed **sand dunes** on the valley trains or on the adjacent uplands. In places, sand dunes have migrated up to 10 miles away from the principle source of sand. Flat areas between dunes are generally underlain by eolian **sheet sand** that is commonly reworked by water action. On uplands along the major valley trains, loess and eolian sand are commonly interbedded. With increasing distance from the valleys, the eolian sand pinches out, often within one mile.

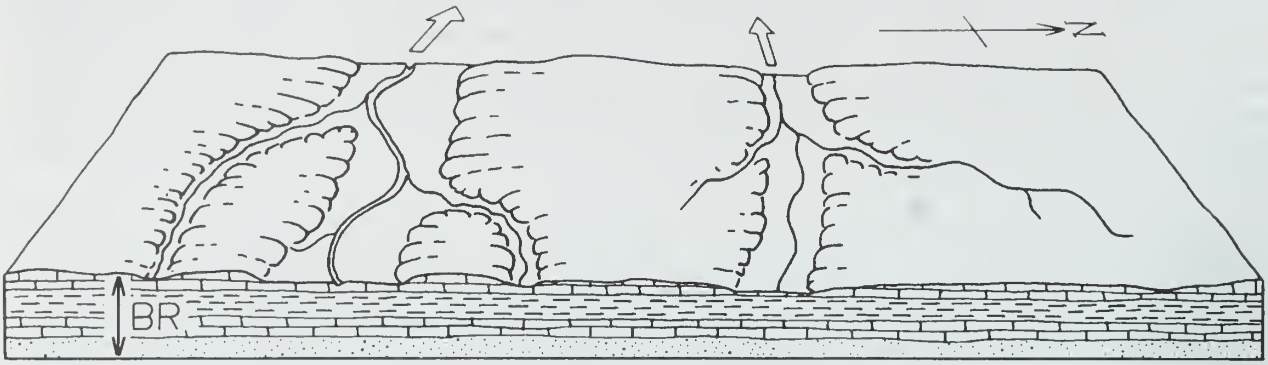
Eolian deposition occurred when certain climatic conditions were met, probably in a seasonal pattern. Deposition could have occurred in the fall, winter or spring season when low precipitation rates and low temperatures caused meltwater floods to abate, exposing the surfaces of the valley trains and permitting them to dry out. During Pleistocene time, as now, west winds prevailed, and the loess deposits are thickest on the east sides of the source valleys. The loess thins rapidly away from the valleys but extends over almost all the state.

Each Pleistocene glaciation was followed by an interglacial stage that began when the climate warmed enough to melt the glaciers and their snowfields. During these warmer intervals, when the climate was similar to that of today, drift and loess surfaces were exposed to weather and the activities of living things. Consequently, over most of the glaciated terrain, soils developed on the Pleistocene deposits and altered their composition, color, and texture. Such soils were generally destroyed by later glacial advances, but some were buried. Those that survive serve as "key beds," or stratigraphic markers, and are evidence of the passage of a long interval of time.

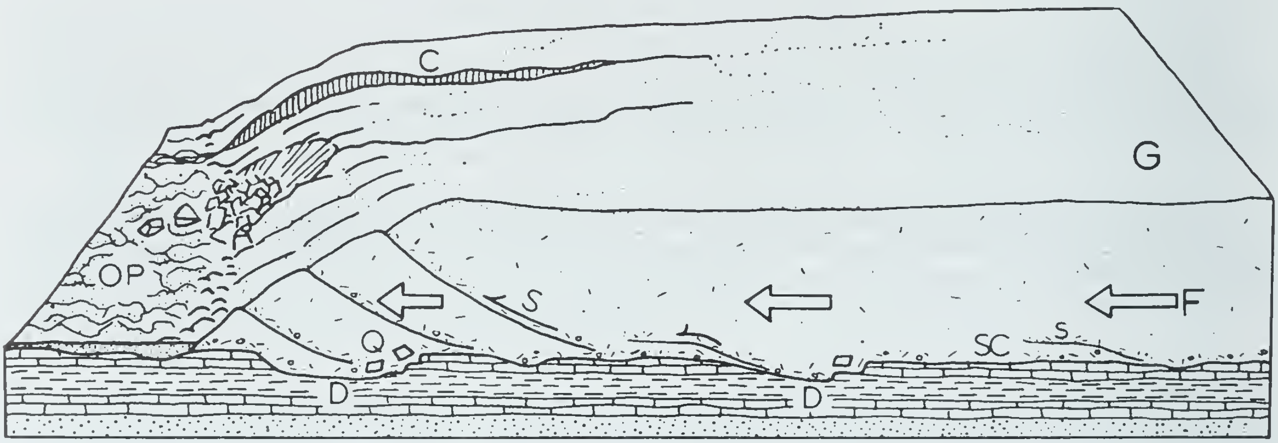
## Glaciation in a Small Illinois Region

The following diagrams show how a continental ice sheet might have looked at various stages as it moved across a small region in Illinois. They illustrate how it could change the old terrain and create a landscape like the one we live on. To visualize how these glaciers looked, geologists study the landforms and materials left in the glaciated regions and also the present-day mountain glaciers and polar ice caps.

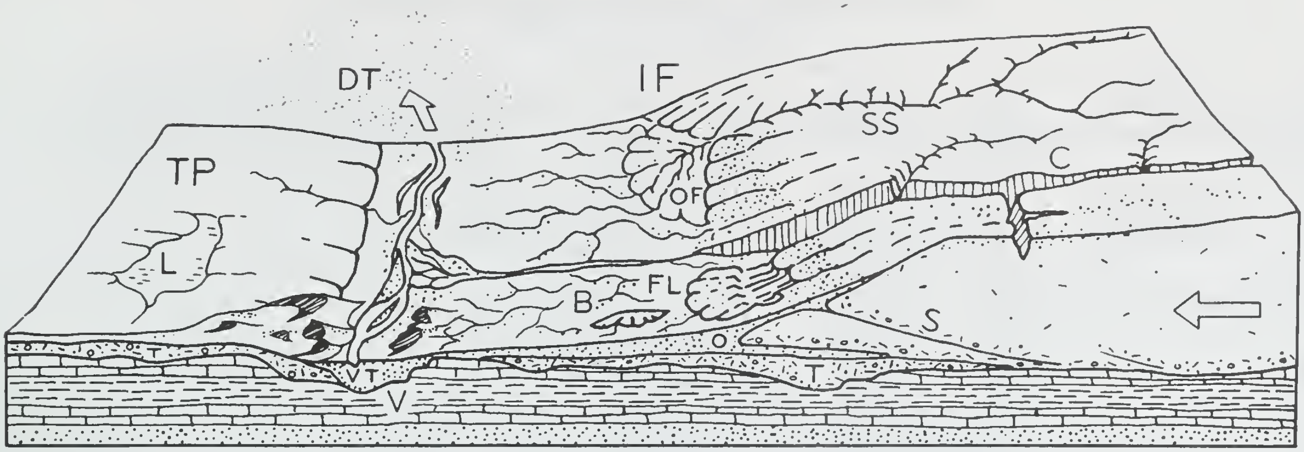
The block of land in the diagrams is several miles wide and about 10 miles long. The vertical scale is exaggerated—layers of material are drawn thicker and landforms higher than they ought to be so that they can be easily seen.




1. **The Region Before Glaciation** — Like most of Illinois, the region illustrated is underlain by almost flat-lying beds of sedimentary rocks—layers of sandstone ( ), limestone ( ), and shale ( ). Millions of years of erosion have planed down the bedrock (BR), creating a terrain of low uplands and shallow valleys. A residual soil weathered from local rock debris covers the area but is too thin to be shown in the drawing. The streams illustrated here flow westward and the one on the right flows into the other at a point beyond the diagram.



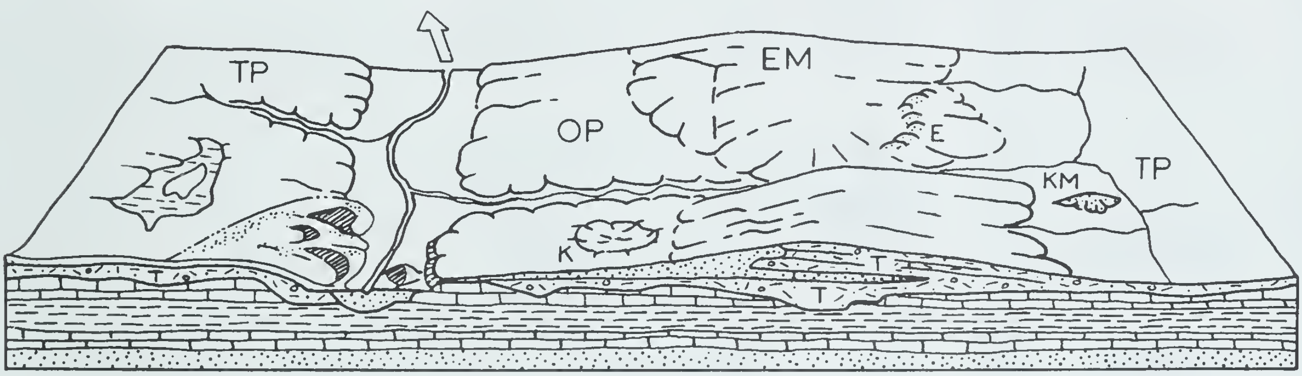

2. **The Glacier Advances Southward** — As the Glacier (G) spreads out from its ice snowfield accumulation center, it scours (SC) the soil and rock surface and quarries (Q)—pushes and plucks up—chunks of bedrock. The materials are mixed into the ice and make up the glacier's "load." Where roughnesses in the terrain slow or stop flow (F), the ice "current" slides up over the blocked ice on innumerable shear planes (S). Shearing mixes the load very thoroughly. As the glacier spreads, long cracks called "crevasses" (C) open parallel to the direction of ice flow. The glacier melts as it flows forward, and its meltwater erodes the terrain in front of the ice, deepening (D) some old valleys before ice covers them. Meltwater washes away some of the load freed by melting and deposits it on the outwash plain (OP). The advancing glacier overrides its outwash and in places scours much of it up again. The glacier may be 5000 or so feet thick, and tapers to the margin, which was probably in the range of several hundred feet above the old terrain. The ice front advances perhaps as much as a third of a mile per year.




3. **The Glacier Deposits an End Moraine** — After the glacier advances across the area, the climate warms and the ice begins to melt as fast as it advances. The ice front (IF) is now stationary, or fluctuating in a narrow area, and the glacier is depositing an end moraine.

As the top of the glacier melts, some of the sediment that is mixed in the ice accumulates on top of the glacier. Some is carried by meltwater onto the sloping ice front (IF) and out onto the plain beyond. Some of the debris slips down the ice front in a mudflow (FL). Meltwater runs through the ice in a crevasse (C). A supraglacial stream (SS) drains the top of the ice, forming an outwash fan (OF). Moving ice has overridden an immobile part of the front on a shear plane (S). All but the top of a block of ice (B) is buried by outwash (O).

Sediment from the melted ice of the previous advance (figure 2) remains as a till layer (T), part of which forms the till plain (TP). A shallow, marshy lake (L) fills a low place in the plain. Although largely filled with drift, the valley (V) remains a low spot in the terrain. As soon as the ice cover melts, meltwater drains down the valley, cutting it deeper. Later, outwash partly refills the valley: the outwash deposit is called a valley train (VT). Wind blows dust (DT) off the dry floodplain. The dust will form a loess deposit when it settles. Sand dunes (D) form on the south and east sides of streams.




4. **The Region after Glaciation** — As the climate warms further, the whole ice sheet melts, and glaciation ends. The end moraine (EM) is a low, broad ridge between the outwash plain (OP) and till plains (TP). Run-off from rains cuts stream valleys into its slopes. A stream goes through the end moraine along the channel cut by the meltwater that ran out of the crevasse in the glacier.

Slopewash and vegetation are filling the shallow lake. The collapse of outwash into the cavity left by the ice block's melting has made a kettle (K). The outwash that filled a tunnel draining under the glacier is preserved in an esker (E). The hill of outwash left where meltwater dumped sand and gravel into a crevasse or other depression in the glacier or at its edge is a kame (KM). A few feet of loess covers the entire area but cannot be shown at this scale.

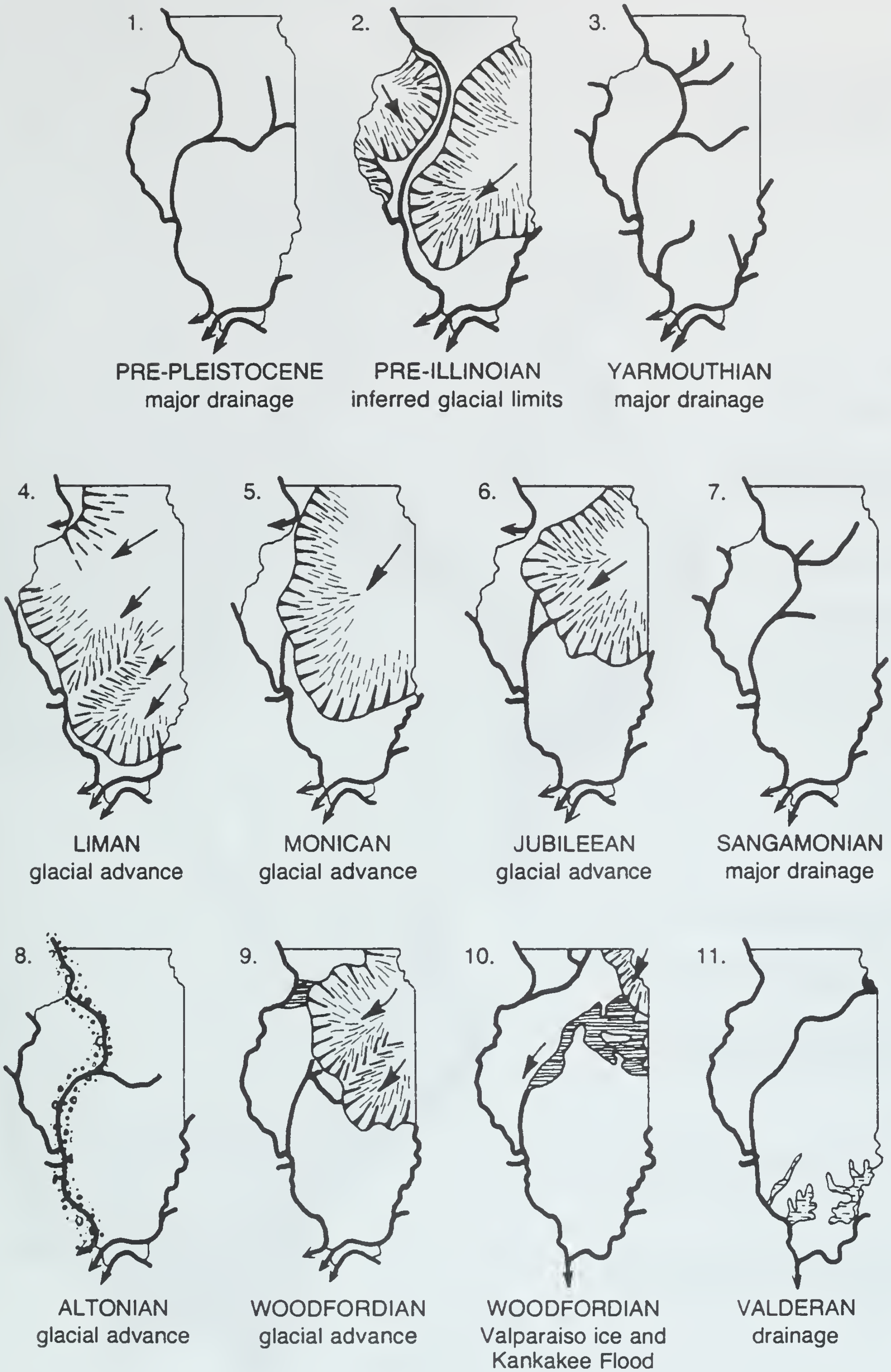
TIME TABLE OF PLEISTOCENE GLACIATION

| | | STAGE | | SUBSTAGE | NATURE OF DEPOSITS | SPECIAL FEATURES |
|---|---|---|---|---|---|---|
| QUATERNARY | | HOLOCENE (interglacial) | | Years Before Present | Soil, youthful profile of weathering, lake and river deposits, dunes, peat | |
| | | | | 10,000 | | |
| | Pleistocene | WISCONSINAN (glacial) | | Valderan | Outwash, lake deposits | Outwash along Mississippi Valley |
| | | | | 11,000 | | |
| | | | | Twocreekan | Peat and alluvium | Ice withdrawal, erosion |
| | | | | 12,500 | | |
| | | | late | Woodfordian | Drift, loess, dunes, lake deposits | Glaciation; building of many moraines as far south as Shelbyville; extensive valley trains, outwash plains, and lakes |
| | | | | 25,000 | | |
| | | | mid | Farmdalian | Soil, silt, and peat | Ice withdrawal, weathering, and erosion |
| | | | | 28,000 | | |
| | | | early | Altonian | Drift, loess | Glaciation in Great Lakes area, valley trains along major rivers |
| | | | | 75,000 | | |
| | | SANGAMONIAN (interglacial) | | | Soil, mature profile of weathering | Important stratigraphic marker |
| | | | | 125,000 | | |
| | | ILLINOIAN (glacial) | | Jubileean | Drift, loess, outwash | Glaciers from northeast at maximum reached Mississippi River and nearly to southern tip of Illinois |
| | | | | Monican | Drift, loess, outwash | |
| | | | | Liman | Drift, loess, outwash | |
| | | | | 300,000? | | |
| | | YARMOUTHIAN (interglacial) | | | Soil, mature profile of weathering | Important stratigraphic marker |
| | | | | 500,000? | | |
| | Pre-Illinoian | KANSAN* (glacial) | | | Drift, loess | Glaciers from northeast and northwest covered much of state |
| | | | | 700,000? | | |
| | | AFTONIAN* (interglacial) | | | Soil, mature profile of weathering | (hypothetical) |
| | | | | 900,000? | | |
| | | NEBRASKAN* (glacial) | | | Drift (little known) | Glaciers from northwest invaded western Illinois |
| | | | | 1,600,000 or more | | |

*Old oversimplified concepts, now known to represent a series of glacial cycles.

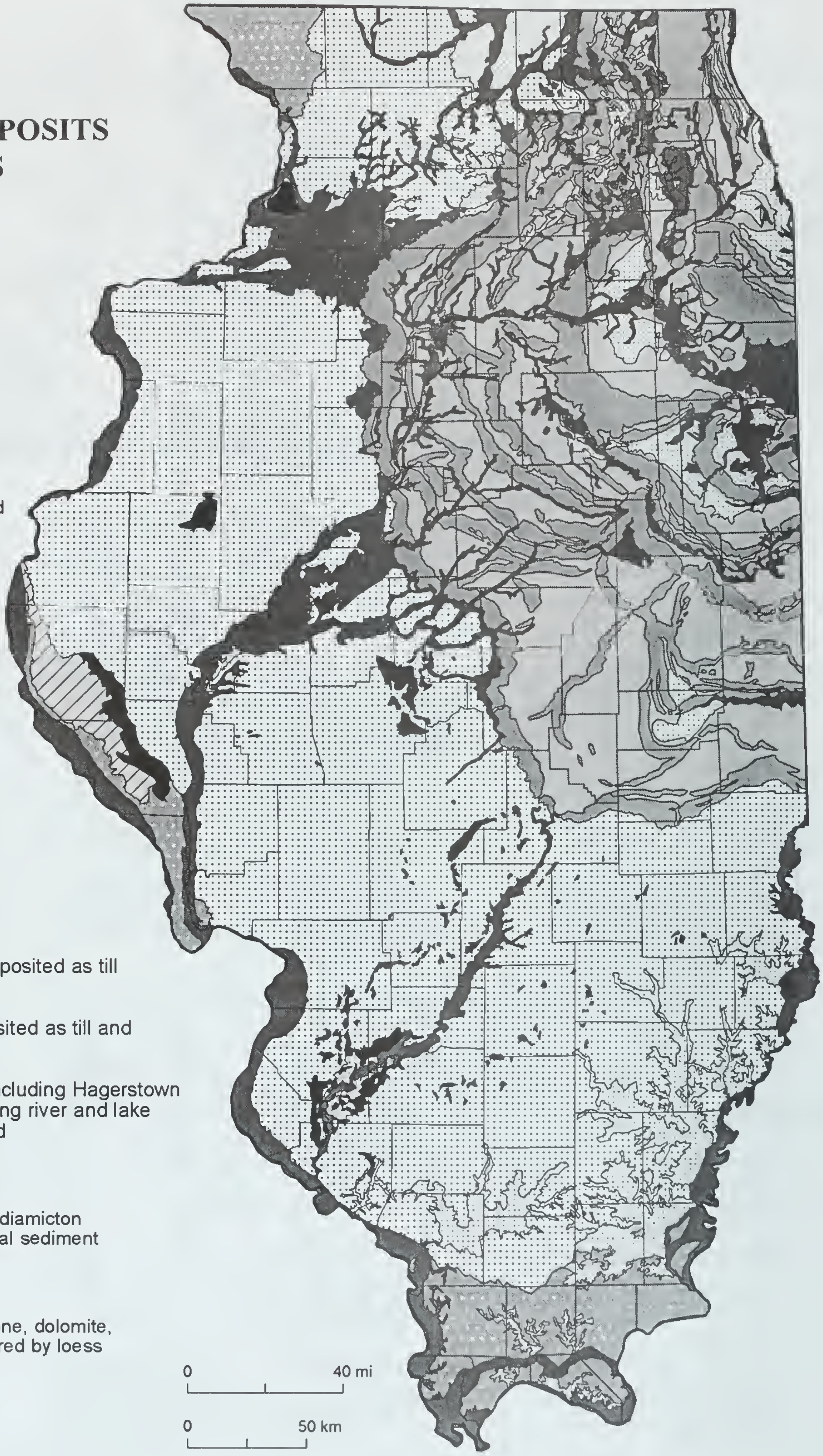
(Illinois State Geological Survey, 1973)

SEQUENCE OF GLACIATIONS AND INTERGLACIAL DRAINAGE IN ILLINOIS




(Modified from Willman and Frye, "Pleistocene Stratigraphy of Illinois," ISGS Bull. 94, fig. 5, 1970.)

# QUATERNARY DEPOSITS OF ILLINOIS




Hudson and Wisconsin Episodes

Mason Group and Cahokia Fm

Cahokia and Henry Fms; sorted sediment including waterlain river sediment and windblown and beach sand

Equality Fm; fine grained sediment deposited in lakes

—5— Thickness of Peoria and Roxana Silts; silt deposited as loess (5 ft contour interval)

Wedron Group (Tiskilwa, Lemont, and Wadsworth Fms) and Trafalgar Fm; diamicton deposited as till and ice-marginal sediment

End moraine

Ground moraine

Illinois Episode

Winnebago Fm; diamicton deposited as till and ice-marginal sediment

Glasford Fm; diamicton deposited as till and ice-marginal sediment

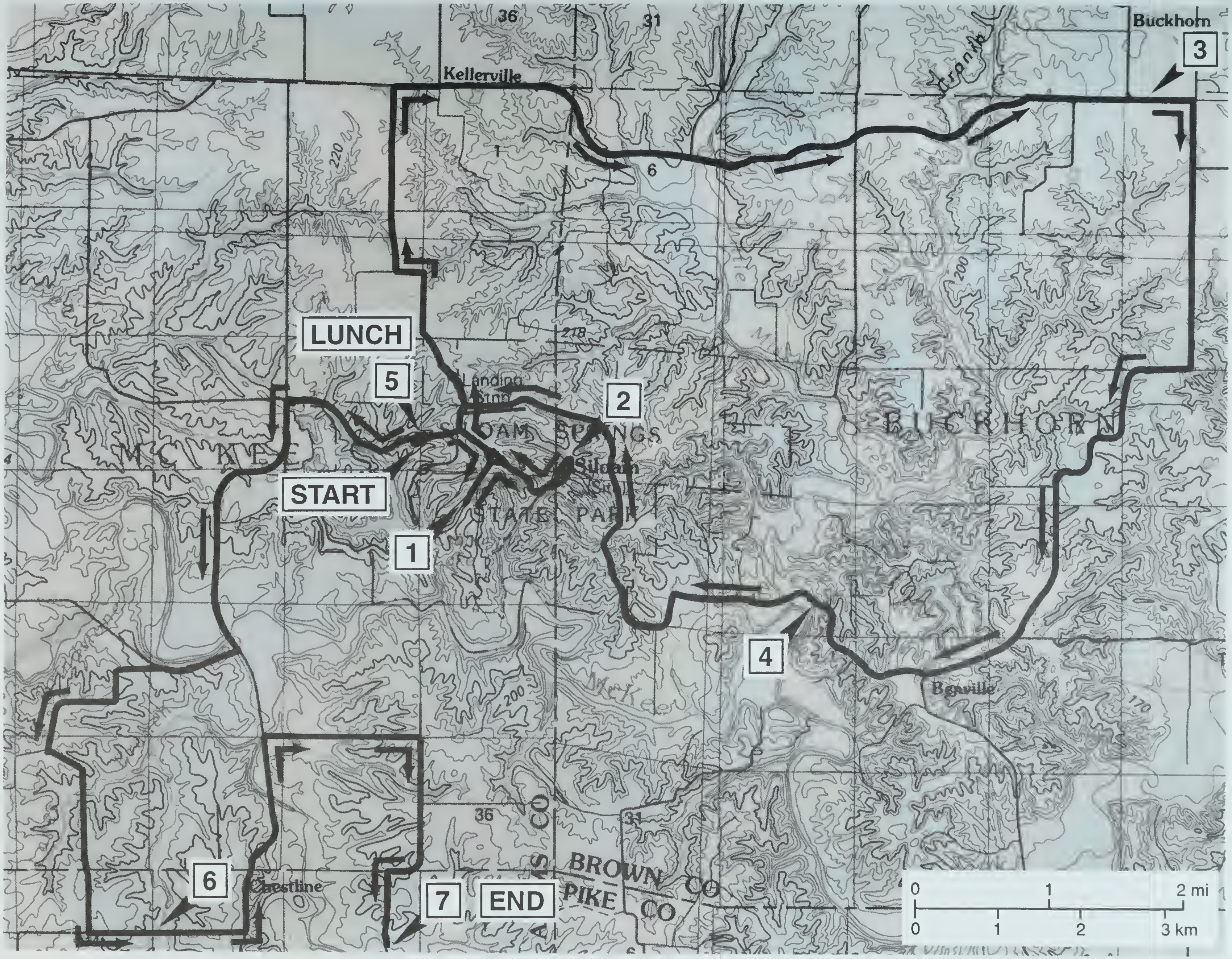
Teneriffe Silt and Pearl Fm, including Hagerstown Mbr; sorted sediments including river and lake deposits and wind blown sand

Pre-Illinois Episodes

Wolf Creek Fm; predominantly diamicton deposited as till and ice-marginal sediment

Paloezoic, Mesozoic, and Cenozoic

Mostly Paleozoic shale, limestone, dolomite, or sandstone; exposed or covered by loess and/or residuum



Kellerville
Buckhorn
3
LUNCH
5
2
START
1
4
6
Crestline
7
END
BUCKHORN
MC KEE
SILOAM SPRINGS
STATE PARK
Siloam
Landing
Bgsville
BROWN CO
PIKE CO
36
31
6
220
200
170
218
0 1 2 mi
0 1 2 3 km